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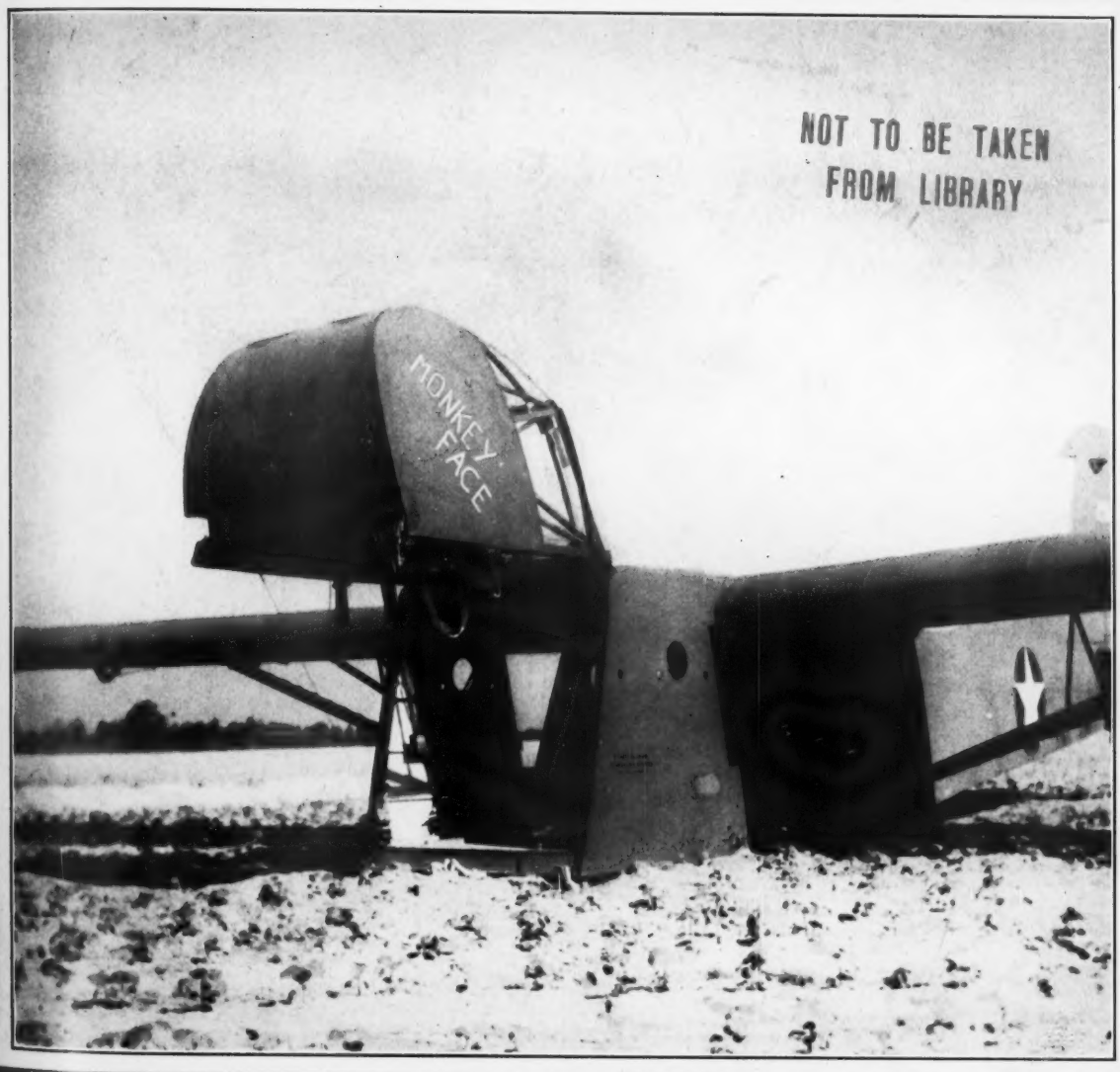

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The Control of Life Expectancy in Airplane Structures*

REGINALD B. BLAND† AND PAUL E. SANDORFF†

Lockheed Aircraft Corporation

Reginald B. Bland

ABSTRACT

The subject of design for limited service life is introduced and the advantages of such design are cited. Design trends are presented to show that fatigue troubles are probably on the increase and that to minimize fatigue troubles it will be necessary to design for a definite life expectancy.

Methods of presentation of information regarding anticipated service loading and the fatigue properties of materials and constructions are described, and their correlation is discussed. It is pointed out that such information is currently inadequate yet must be obtained in the near future.

INTRODUCTION

EVERY AIRPLANE DESIGNER knows of structural components that successfully pass the requirements for static strength and that nonetheless prove unsatisfactory in service and must be strengthened or redesigned. Service records indicate that in over 90 per cent of the recorded instances, the unsatisfactory behavior of these components is due to the accumulative action of dynamic stresses.

The appreciation of the fact that the loads imposed upon an airplane are always dynamic in nature ultimately forces a correlation of the number and severity of expected loadings with the fatigue characteristics of the various components of the airplane. With such a correlation, the aeronautical engineer may design his structural components so that they will never fail—i.e., so that the airplane has an infinite service life—or he may elect to design so that his structural components possess a definite life expectancy.

It is the purpose of this paper to show that, given certain information, the design of airplane structural components on the basis of life expectancy is entirely feasible, that definite advantages will acrue to the operator if his airplanes are so designed, and that the trend of current design is such that life expectancy must be seriously considered in the future.

A distinction may be drawn between fatigue failures occurring in items of equipment and failures occurring in the air frame. Equipment failures, while important,[1] are intentionally excluded from the discussion given in this paper.

LIFE EXPECTANCY IN AIRPLANE STRUCTURAL DESIGN

Life Expectancy as a Criterion in Structural Design

The use of life expectancy as a criterion in structural design is not new. Ball bearings and roller bearings have long been rated on this basis.[2, 3] The automobile industry is similarly rating such items as rear axles and springs,[4] and, in civil engineering, bridges and other structures are subjected to this kind of analysis.[5] In Germany, the importance of this problem in all fields of engineering, including aircraft, has been recognized for years and considerable progress has been made in that country (see Kaul,[6] Krumbholz,[7] Kuessner,[8] Nissen,[9] Bollenrath,[10] Thum,[11] and others).

Paul E. Sandorff

Increased Accuracy of Design

The primary benefits of structural design based on a knowledge of life expectancy lie in the increased guarantee of trouble-free service life. Such design would ultimately lighten much of the structure which is now wastefully overstrength and overweight. A sizable amount of this wasteful weight is tied up in arbitrary design requirements, such as the factor of 1.5 for engine mounts,[12] the factor of 2.0 for castings,[12] and the fitting factors applied to lugs and shear pins,[12] which have served to make structural design on the basis of statics blindly conservative.

Economic Aspects

Economic advantages are realized in the reduction of maintenance problems and costs and in the fact that these costs, to a certain extent, will be predictable. In this connection it will be necessary to include requirements concerning the design service life when performance specifications are written.

The determination of the design service life will hinge on the long-range purpose of the airplane: first, when will the airplane become obsolescent; second, after obsolescence, is its useful life concluded—i.e., will it be junked or sal-

* The authors wish to express their appreciation to C. J. Henkel for many valuable suggestions made during the writing of this paper.

† Senior Research Engineers.

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vaged or converted into a second-rate carrier with an anticipated increase in maintenance cost? The aid of the operator must be enlisted to obtain the best answers to these questions.

Once the general specifications have been determined, it may be found economically advantageous to design certain structural components for periodic replacement during the service life of the airplane. Such practice has already been established with great success in the case of propellers and of power plants, as well as with gear boxes, control systems, and other parts that are readily replaceable.

Are Fatigue Troubles on the Increase?

Major Trends in Design

A survey of the development of the modern all-metal airplane during the past ten years reveals certain major trends in design. Four of these trends are of great importance in relation to the subject matter of this paper: the drive toward higher cruising speeds shown in Fig. 1;[13] the tendency to increase the ratio of useful load to gross weight shown in Fig. 2;[13] the increase in wing loadings shown in Fig. 3;[13] the increase in gross weight shown in Fig. 4[13] and its relationship to reduced load factors allowed by the various governmental agencies.[14, 15] The trend of design load factor is shown in Fig. 5.

These trends are normal and understandable, since the commercial operator must always consider the revenue accruing from his operations and the military services must always emphasize the questions of useful load and of speed. But, as will be shown below, these trends move us inevitably toward a situation where the dynamic strength of our structures must be considered an integral part of our design calculations.

Effect of Design Trends

Consider first the trend toward increased speed. This has been brought about by an increase in engine horsepower, by more efficient aerodynamic design, by increased wing loading, and by increased operational altitudes made possible by cabin supercharging. Since the miles flown per unit time are proportional to speed, then for equal number of flying hours this trend has augmented both the severity and the number of loads to be expected during service life of the airplane.

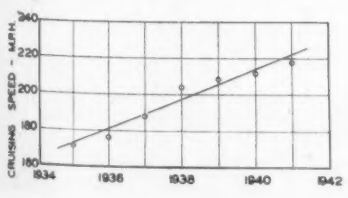

Fig. 1. Trend of cruising speed. Average for commercial landplanes over 10,000 lbs. gross weight.

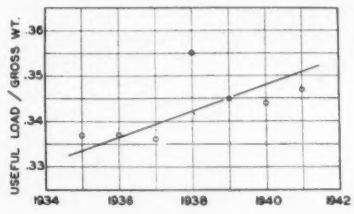

Fig. 2. Trend of ratio of useful load to gross weight. Average for commercial landplanes over 10,000 lbs.

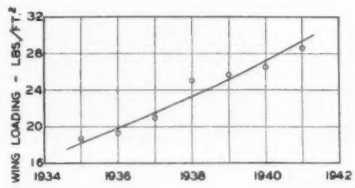

Fig. 3. Trend of wing loading. Average for commercial landplanes over 10,000 lbs. gross weight.

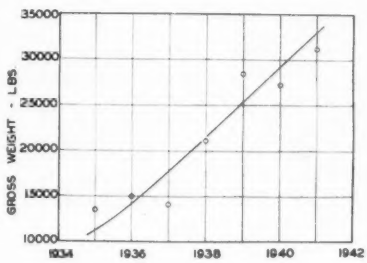

Fig. 4. Trend of average size of commercial landplanes over 10,000 lbs. gross weight.

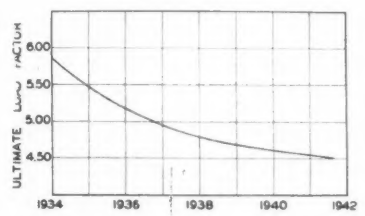

Fig. 5. Trend of design (ultimate) load factor. Commercial landplanes over 10,000 lbs. gross weight.

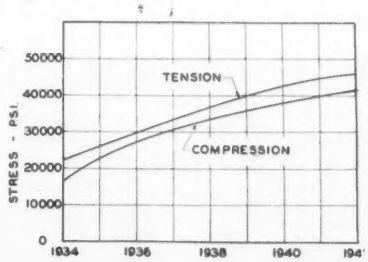

Fig. 6. Trend of wing surface stresses at design (ultimate) load factor in commercial landplanes over 10,000 lbs. gross weight.

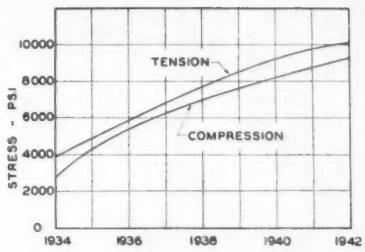

Fig. 7. Trend of wing surface stress at one load factor in commercial landplanes over 10,000 lbs. gross weight.

Next consider the trend toward increased ratio of useful load to gross weight. This trend is concurrent with more efficient structural designs that use less material and possess smaller excess margins of safety. Increased attention is necessarily given to the critical points, such as splices and joints, to increase their efficiency under static load. The industry is turning to the use of higher-strength materials in which the yield strength is much closer to the ultimate strength and in which manufacturing control, in relation to the establishment of guaranteed values, has been considerably improved.

The trend toward increased ratio of useful load to gross weight is therefore indicative of a simultaneous increase in design stresses, which is shown in Fig. 6.

Now consider the trend toward increased wing loading. Since the severity of aerodynamic gust loading is inversely proportional to wing loading, the effect of this trend is to reduce the design load factor and, hence, to increase the working stresses at one load factor.

Finally, consider the trend toward increased gross weight. This has directly resulted in a reduction of design load factors and, hence, has led to an increase in the working stresses at one load factor.

The accumulative effect of these design trends has therefore considerably increased the design stresses at one load factor, as shown in Fig. 7. In addition, the trend toward increased speed, plus the increase in service life necessitated by high initial cost, has increased both the severity and the total number of cycles of expected loading shown in Fig. 8.

The foregoing study appears to indicate that fatigue troubles are potentially on the increase. Analysis of service records bears out this point, since such analysis shows that for comparable design a rough correlation exists between an increase in the working stress and the number of structural fatigue failures recorded.

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Anticipated Service Loadings

The problem of structural design deals with the determination of the design conditions that then must be correlated with the structural properties of the material being considered to achieve an efficient solution. Design on the basis of life expectancy is a complicated process because it is necessary to consider not a single load applied merely once but the total probable number of applications of any possible loading condition. The accuracy of design therefore depends to a large extent on having a practical means of correlating the design requirements and both the static and dynamic characteristics of the structure being investigated.

Types of Loading

The simplest type of dynamic loading is that in which the stress is completely reversed, i.e., a stress that varies between two equal values of tension and compression. For successive cycles the magnitude of the maximum stress may be different, but the maximum values of tension and compression will still remain arithmetically equal (see Fig. 9a). Such conditions may be expected, e.g., in control parts or in hinge brackets. It is necessary to know in this case how many cycles of the completely reversed stress are anticipated at all possible values of the maximum stress.

Other types of loading are possible. For instance, in certain landing gear parts or in rudder pedals it would be expected that the applied stress would vary from zero to a maximum value in one cycle (Fig. 9b). In other cases the part may be considered subject to a constant mean stress, upon which is superimposed a cyclic varying stress. In the case of motor mounts, control rods, or skin structure that is subjected to propeller blast, the latter type of loading usually applies, with the maximum stress generally remaining constant as in Fig. 9c, so that a knowledge only of the magnitude of the stress cycle and the number of anticipated applications is necessary. Wing structure is also of related type since it must carry a certain initial load corresponding to one load factor in flight and must withstand superimposed loads due to gusts and maneuvers that vary in magnitude. Hence, wing stresses are frequently considered to be of the "constant mean stress, variable maximum stress" type indicated in Fig. 9d.

And then, of course, it may be expected that some parts are subjected to a completely irrational type of loading (Fig. 9e) in which everything varies: the mean stress, the opposite lobes of the cycle, the maximum and minimum values of stress, and the shape of the loading curve. All parts are to some extent subject to irrational loading, but for purposes of analysis it is usually sufficient to consider only the more specific types.

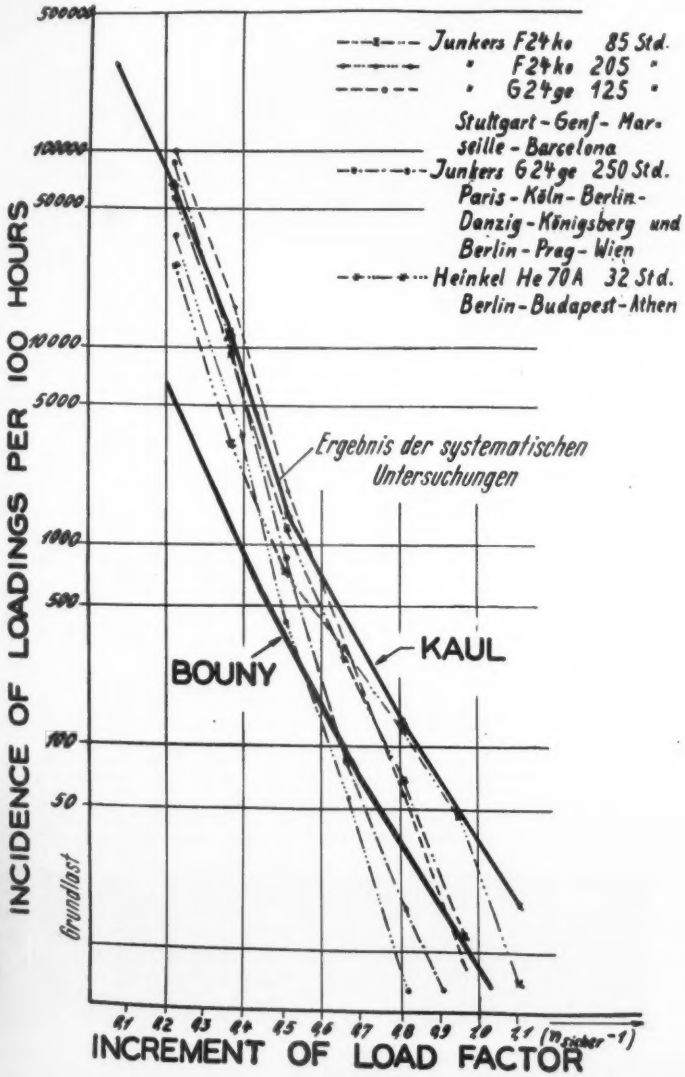

Fig. 8. Incidence of loadings per 100 hours of flight according to foreign investigations.

Determination of Anticipated Service Loading

The anticipated service loading can best be determined from statistical flight data. Investigations of this nature have been pursued for several years in foreign countries, as evidenced by the accelerometer measurements of Kaul[6] and Bouny.[16] These data were usually obtained with instruments that counted the total number of times the acceleration measured at the center of gravity exceeded certain values. Thus, after several hundred hours of operation it was possible to express the statistical data in a form similar to that given in Fig. 8.

In this country we have made much use of the data presented by Rhode,[17] whose gust-distribution curve is reproduced as Fig. 10. This curve appears to have led many engineers to believe that structural fatigue failures will never be important, but it should be remembered that the majority of data were obtained on airplanes—Ford and Fokker trimotors—that are now obsolete. A small amount of data is now available from various test flights, but these data are of confidential status and, hence, are not presented in this paper. A noteworthy point is that, while in Germany and elsewhere data are presented in the form of acceleration (or additional load-factor), practically all available data in this country are presented in the form of effective gust velocity, which stems initially from acceleration measurements.

Although data expressed in the form of effective gust velocity are undoubtedly of much wider application than data expressed in the form of accelera-

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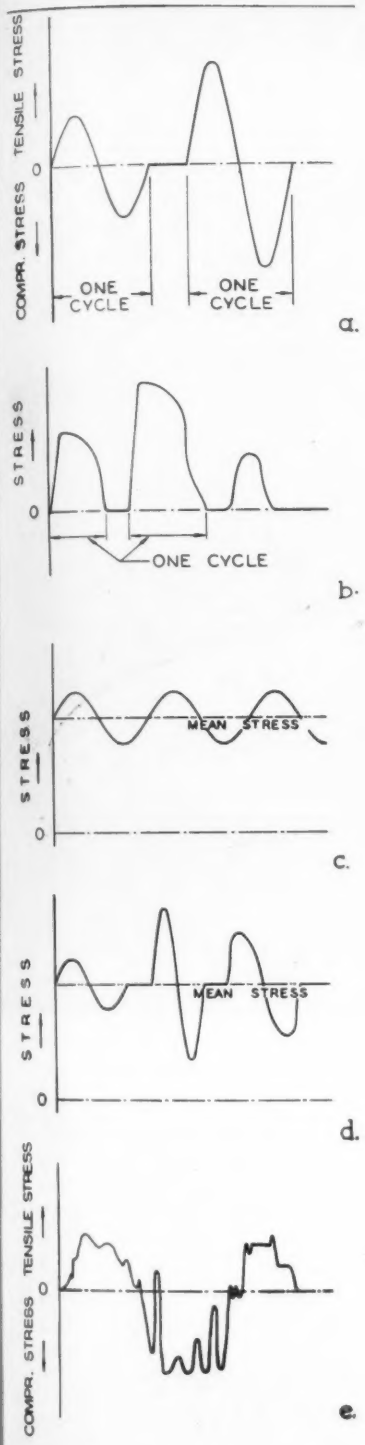


FIGS. 9a–9e. Types of dynamic loading

tion units, yet both forms of expression are useless for the purpose of design on the basis of life expectancy except for purely vertical loadings and for structure relatively near the center of gravity of the airplane. It is definitely known that accelerometer measurements taken at the center of gravity under unsteady flight conditions do not necessarily bear any real relation to actual stresses at other points and that accelerometer measurements at locations away from the center of gravity do not necessarily bear any real relation to any stresses anywhere in the ship. In addition, such data as are available are applicable only to airplanes of speed, wing loading, size, and mission similar to those in which the data were obtained; also, general meteorologic conditions vary widely in different areas and in different seasons, and a correlation is therefore necessary.

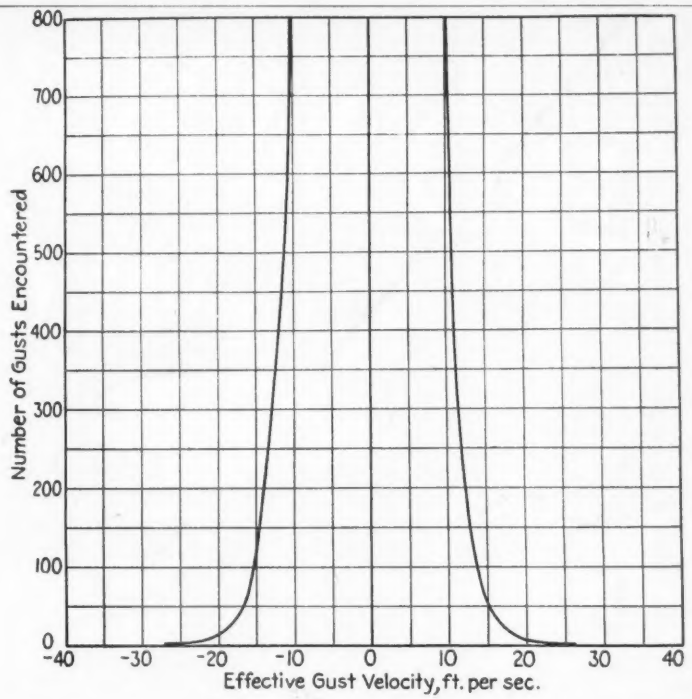


FIG. 10. Frequency distribution of gust intensity during 1,320 hours according to American investigations.

With recent advances in instrumentation the study of stresses occurring in structural members under service conditions has become relatively simple and is being pursued by many progressive airplane manufacturers. Records of admirable work in this field by The Glenn L. Martin Company are published in the August issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.[18] Obviously, the application of this instrumentation to a systematic accumulation of statistical data will be of immense value to the industry of the future. It should be remembered, however, that pertinent information concerning the flight conditions, airplane characteristics, meteorology, topography, etc., is extremely important for proper statistical analysis.

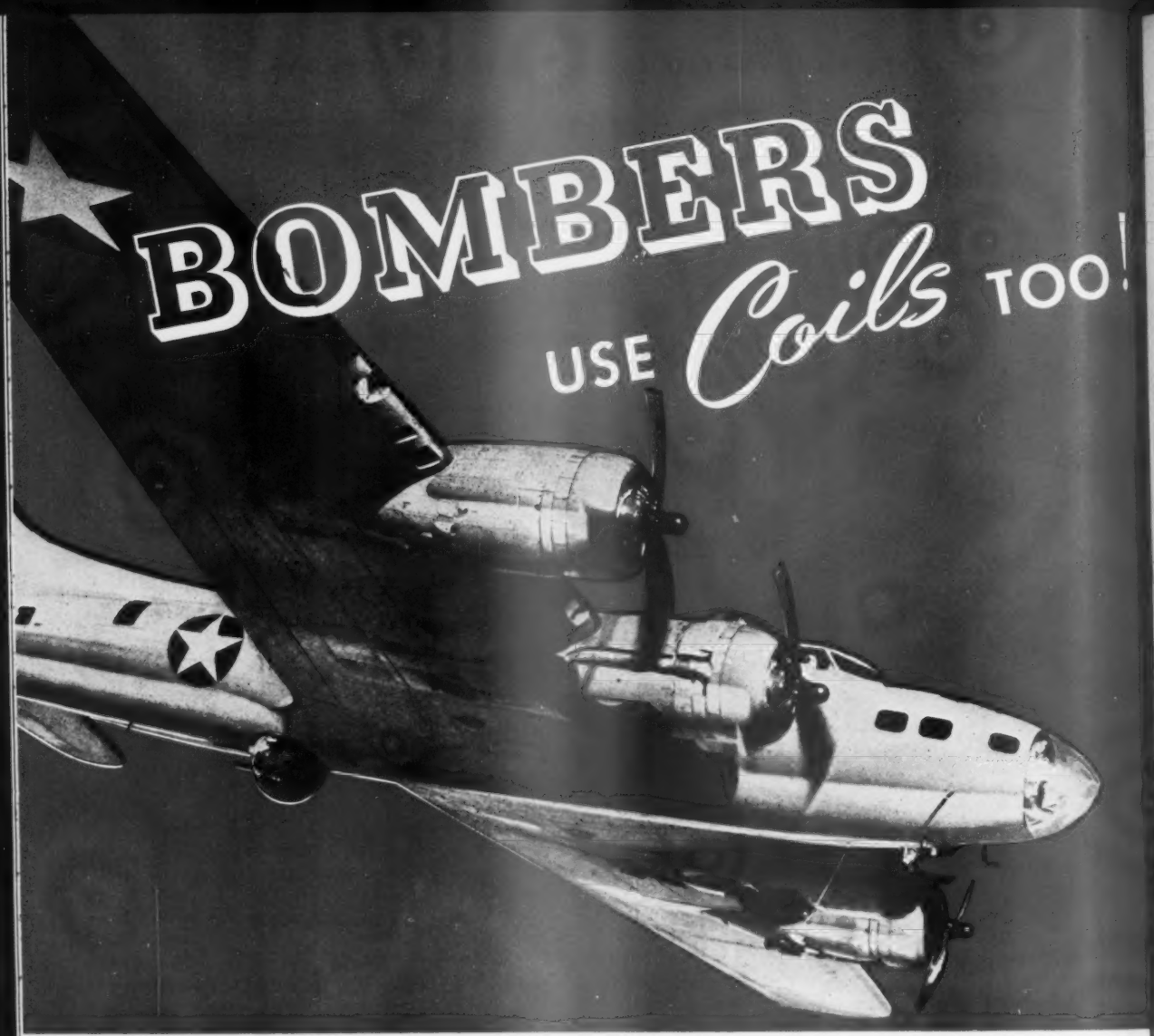
When adequate statistical data become available, the design conditions may be estimated by logical processes. The accuracy of such an estimation is, of course, directly dependent on the quantity and quality of data at hand.

Means of Representing Service Loadings

The loading condition illustrated in Fig. 9c may be defined completely by reference to the value of the mean stress, the maximum value of the varying stress, and the number of cycles of application. In all other cases, however, it is necessary to resort to a graphic presentation in which the maximum value of the variable stress is shown as a function of the number of cycles. Such a presentation is termed a "distribution curve" and may be applied with success to the types of loading of Figs. 9a, 9b, and 9d. Fig. 10 illustrates the nature of the distribution curve; in this case the variable quantity is effective gust velocity and not stress.

While the distribution curve expresses the relative number of cycles to be expected at any given maximum value of the variable stress, it is not indicative of the actual total loading that the part must withstand. A summation curve is therefore found more useful. Any point on the summation curve expresses the total number of cycles to be expected to exceed this severity. This is the type of data obtained from accelerometer counters (Fig. 8).

The general case of Fig. 9e is more difficult to define. A suggested method of presenting a family of summation curves is discussed later.



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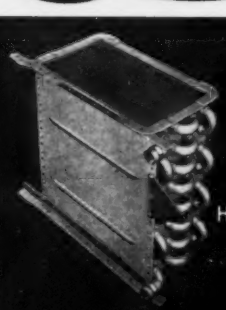

AIRCRAFT HEATING SECTION

AIRCRAFT HEATING ASSEMBLY

AIRCRAFT CABIN HEATER

Fatigue Strength of Structural Components

Need for Full-Scale Tests

The first fatigue tests ever recorded were made on full-scale specimens and on actual structural components.[19, 20] As the intricacy of the problem became recognized, laboratory tests were instituted in order to reduce the amount of labor and expense involved and to determine the cause of the phenomenon of failure under repeated stress with the hope of eventually applying such test data to full-scale design. These tests have been continued to the point where considerable data are now available on the basic endurance limits of many different materials. The practical application of these data, which are usually obtained with highly polished, small size specimens, to full-scale fabricated structures that must withstand repeated loadings for a definite time is still nearly impossible. It has therefore again become necessary to resort to full-scale accelerated testing in order to determine the actual fatigue strength of the structural components in question.

The number of structural components that appear to require investigation is not exceptionally large, since good design practice has conventionalized aircraft structure to a large extent. Effort should be directed to points of obvious stress concentration: welds, lugs, riveted joints, cut-outs, etc. Panel structures must be tested to determine buckling effects and the parasitic effect of rivets and spot welds on the attainable material strength.

Obtaining the Data

There are many types of fatigue test machines commercially available. Many aircraft manufacturers have constructed their own apparatus to suit their individual desires, and for large scale work the principles of resonance testing have been widely used. Most types of test apparatus are treated in available literature, and an efficient laboratory staff is quick at improvisation to obtain the necessary test data.

It is in the definition of the term "necessary test data" that difficulty has been experienced. If design is to be based on life expectancy, the determination of the material endurance limit is usually extraneous. The desired data are indicated by the design conditions that the structure will have to meet; therefore, the fatigue strength need only be defined between 1 cycle and, for instance, 10,000,000 cycles. The restriction of the investigation to the useful range considerably reduces the required test time.

The nature of the load to be applied is likewise apparent from the design conditions. Data from rotating beam tests

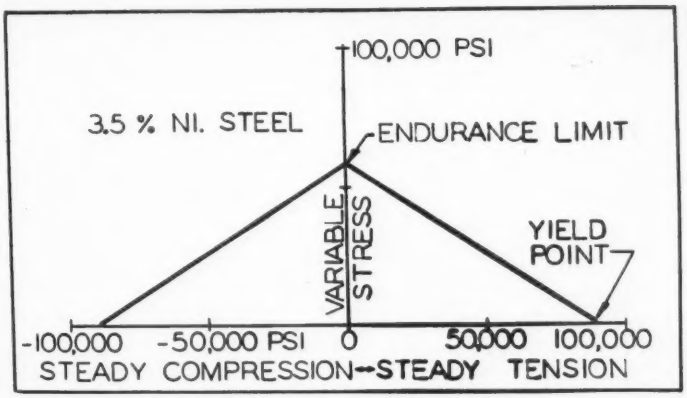

Fig. 11. Soderberg diagram.

can be used in the design of supercharger shafts, but for wing surfaces or landing gear structures such data have little practical value. However, data from axial tension-compression tests are of wide application and may also be conveniently expressed as "R" curves, which will be explained later. Shear or torsion tests are likewise desirable.

Presentation of Fatigue Strength Data

The Soderberg diagram (Fig. 11) and the Goodman diagram[21] (Fig. 12) have been widely used to represent the variation of endurance limit with the applied stress conditions. Because these diagrams generally deal only with the endurance limit and not with the fatigue strength as related to cycle numbers, they have little application in designing for life expectancy.

The necessary data may be presented in the form of mean stress curves, as indicated in Fig. 13. Such curves are useful for certain specific applications. The most satisfactory presentation, however, has been by what may be called "R" curves, which are conventional S-N diagrams (Stress vs. No. of Cycles to Failure) defined for constant values of "R," where "R" is equal to the algebraic ratio of minimum stress to maximum stress in a given cycle of loading. Thus, to test at a value of "R" = −1.0, would mean to apply a completely reversed cyclic varying stress such as indicated in Fig. 9a. An "R" value of zero would represent the loading of Fig. 9b, while a constant "R" value

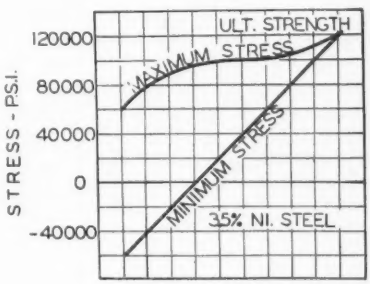

Fig. 12. Goodman diagram.

represents the loading of Fig. 9c. Typical "R" curves for several different materials are presented in Figs. 14, 15, and 16; these curves have been developed from published data.[22]

The use of "R" curves has tremendously broadened the use of fatigue

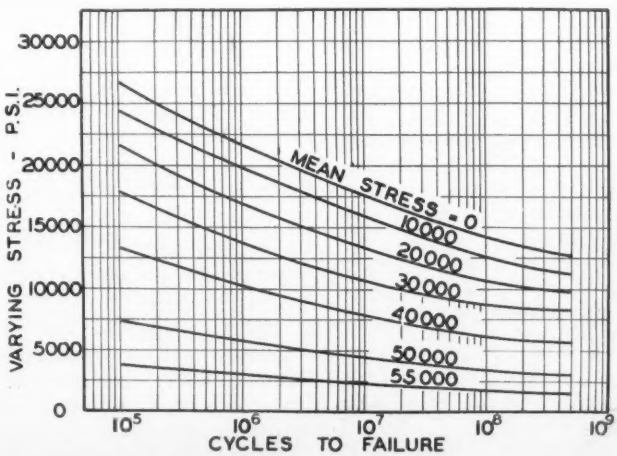

Fig. 13. Mean stress curves for 17S-T aluminum alloy.

data, since they not only present all the various combinations of maximum stress, minimum stress, and number of cycles to failure in a simple, easy-to-use form but also permit the determination of other combinations, such as the mean-stress curve of Fig. 14. While at present their use is restricted to the representation of simple stresses, such as direct tension, compression, or shear, there is every reason to hope that in the near future they may be used to represent combinations of principal stresses, possibly along the lines recently suggested by McAdam.[23]

Correlation of Anticipated Service Loadings with Fatigue Strength Data

It may be stated that the vast majority of service failures can be detected and corrected before a design leaves the drafting board. Not only can these failures be corrected but the criterion of the design service life can be met so that the previously enumerated advantages accrue to the operator. However, at the present time there is a definite lack of the required information. It therefore appears pertinent to define the information that will be required before design for life expectancy can be placed on a rational basis.

First of all, adequate statistical flight data will be required. In general, this requirement cannot be fulfilled by accelerometer measurements made at the center of gravity or at any other place. It can be fulfilled by actual stress measurements, made simultaneously at various stations of the airplane, on various airplanes; correlated and corrected by statistical methods for meteorology, topography, size, speed, wing loading and power loading; and presented in a form that permits of ready correlation with fatigue strength data. Such a form should define the entire stress history of the part under consideration and may be conveniently presented as a family of summation curves at constant values of "R."

Second, adequate fatigue strength data will be required. This does not mean a single test of a single structural component, since such tests are virtually useless at the present time for the purpose of design for life expectancy. It does mean, at least for some time to come, sufficient tests on various structural components so that the fatigue life may be defined for all possible constant conditions of loading. Such a definition is possible if the data are presented in the form of families of "R" curves. It would likewise be highly desirable that sufficient additional data be available so that the corresponding damage curves[24] are defined.

Given the foregoing two items, it becomes possible to develop a correlation.

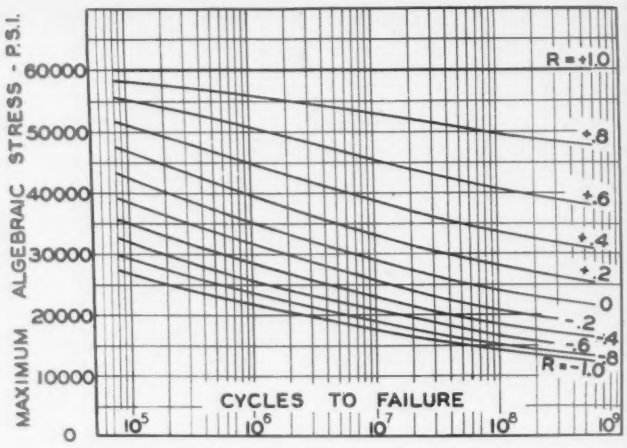

Fig. 14. "R" curves for 17S-T aluminum alloy.

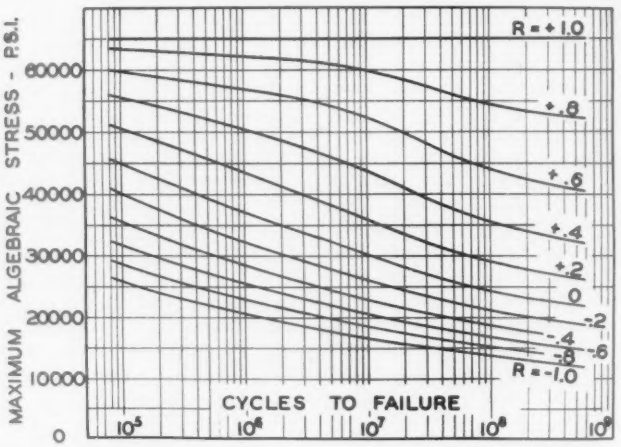

Fig. 15. "R" curves for 27S-T aluminum alloy.

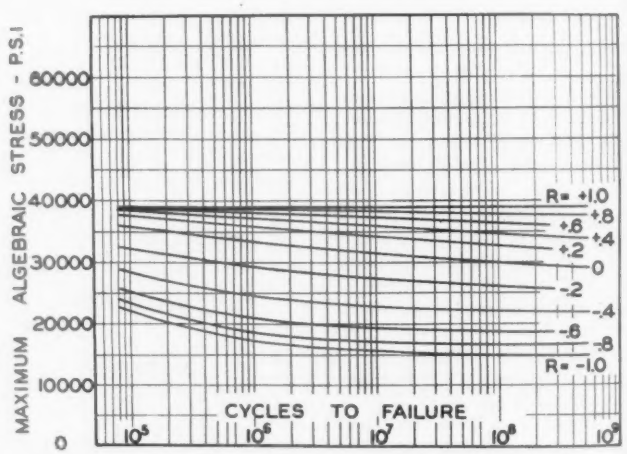

Fig. 16. "R" curves for 52S-3/4H aluminum alloy.

But the correlation must be proved before it can be accepted and put into actual use. Accordingly, further information is required which fortunately is available in the form of service records.

The usual use to which the service records are put is to check for duplication of failures. The first failure, unless disastrous, is not usually regarded as serious; but, as the number of failures multiply, the offending part is strengthened and a few designers store the experience away in their minds. Airplane design gradually improves by this

The B.F.Goodrich Airplane of the month

CURTISS COMMANDO

SHOUTING "GERONIMO," American Paratroops drop on vital installations behind enemy lines. They get there fast . . . and in force . . . in great C-46 Army Transports known as "troopships of the sky." Because of their ability to transport Jeeps, supplies, and field artillery as well, Curtiss Commandos are among the most potent weapons in the United Nations' war bag.

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For the brilliant part it has already played in war theatres, and for its promise of even greater future performance, B. F. Goodrich salutes the Curtiss Commando—Plane-of-the-Month!

In war or peace

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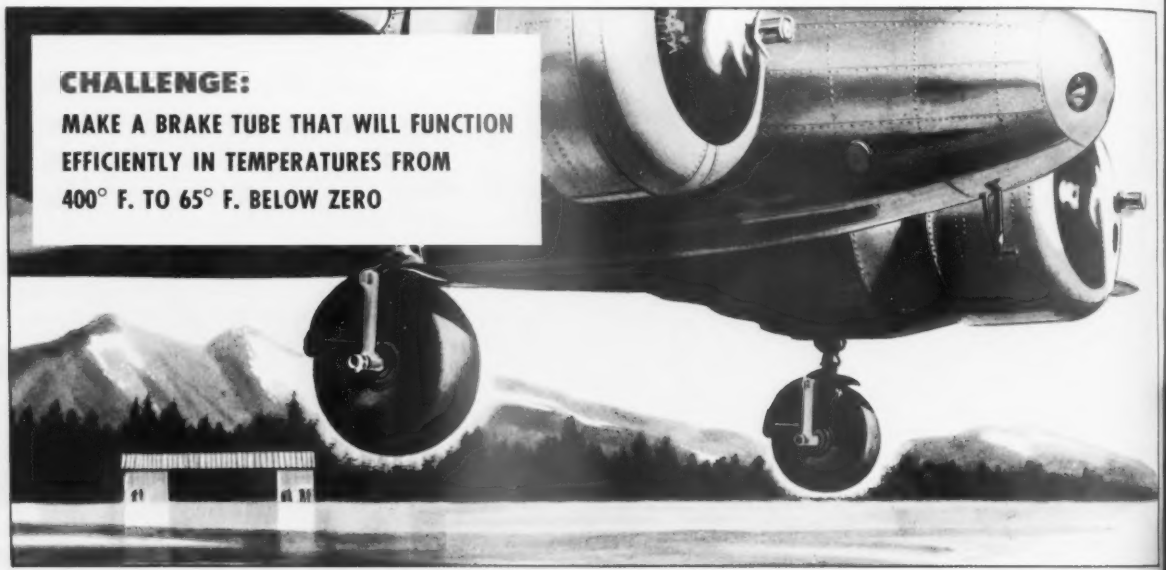
FIRST IN RUBBER

B.F. GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*



THE NEW Air Corps specification was clear enough. It said that from now on expander tubes for ET brakes must operate efficiently in any temperature ranging from about 400° F. to 65° F. below zero. That was the challenge to B. F. Goodrich engineers.

The high temperature figure wasn't a problem. Expander tubes were already made to stand that temperature because of the terrific energy and heat they must absorb in stopping heavy, fast-landing planes. The real challenge was the 65° F. below zero figure. Expander tubes had been acceptable before if they functioned efficiently at −40° F.

The effect of this intense cold on all rubber is to make it brittle and cause it to crack when flexed. Since the main component of an expander tube is synthetic rubber, and since the tube must flex to function, the tendency to crack at low temperatures had to be overcome. And there was another problem. The oil, which had been changed in the brake tube to obtain better flow at low temperatures, was more destructive. To lick these problems a completely new brake tube was needed.

B. F. Goodrich engineers met the challenge two ways: First, a change was made in the shape of the tube opening (see opposite page), which meant that less flexing of the cold tube was required for efficient operation. This greatly relieved the strain on the tube and reduced its tendency to crack at the edges. But the problem of brittleness was still a factor, and the effects of the new, more destructive brake fluid still had to be overcome. This meant a completely new synthetic rubber compound was needed.

Calling on their long experience in compounding synthetic rubber compositions, B. F. Goodrich chemists worked out a combination of synthetic rubbers which they believed would give the necessary resilience at −65° F., work efficiently up to 400° F., and resist the destructive effects of the new brake fluid. Sample brake tubes were made of this compound and tested as shown on the opposite page. The results of these tests (which were more severe than those prescribed by the Air Corps) proved that the new B. F. Goodrich Compound could meet Air Corps specifications.

This is just one more example of the way B. F. Goodrich engineering and research meet changing requirements quickly . . . and come through with the satisfactory solution.

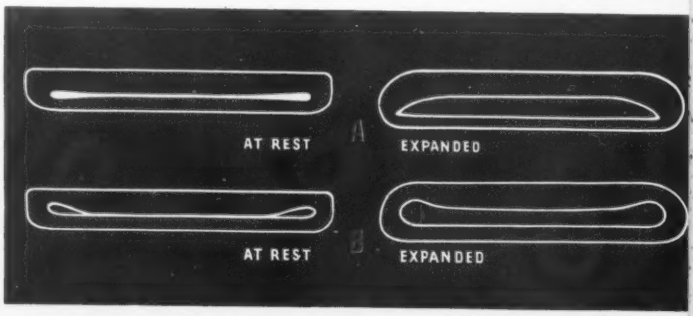
MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

ARMY E NAVY
Awarded in seven plants

Changes in compounding and tube construction mean

BETTER BRAKING AT 65° BELOW

Change in shape of tube opening greatly improved its operating efficiency at low temperatures. As shown at right (A), brake tubes used to have a completely flat opening. As a result, excessive strain was concentrated at the edges when the tube expanded. This caused cracking—especially at low temperatures—and eventually led to complete rupture. To solve this problem, B. F. Goodrich engineers changed the shape of the tube opening (B) to leave small bulges at the edges, which increased the arc at each edge. Thus flexing and strain at the edges were reduced considerably, and one of the main causes of tube failure at low temperatures was eliminated.



New compound put through grueling performance test: Sample expander tubes made of a new synthetic rubber compound developed in B. F. Goodrich Laboratories were first placed in a hot drum (1) at 400° F. for 24 hours. During this time they were flexed 4,400 times with normal brake clearances. Then the tubes were transferred to a cold box (2) at –65° F., kept there 72 hours, then flexed 12 times. The cycle was repeated, and upon completion, the tubes were dissected to see if failures had started at any points. No failures were found.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

GEORGIE GREMLIN STRAINED HIS BRAIN ON THIS

BRAKE QUIZ

CAN YOU SCORE 100%?

Complete the ten statements by simply picking the one correct part (a, b or c) following each numbered statement. See if you can get them all.

1. Expander tube brake clearances should be kept between 15-1000ths and 65-1000ths of an inch because . . .

a. Higher or lower clearances cause gremlinitis.
b. Clearances under 15-1000ths cause excessive drag; over 65-1000ths impair brake efficiency.
c. Improper clearances cause "tube spin."

2. Excessive drag should be guarded against because . . .

a. Drag causes overheating, which may lead to tube failure.
b. Drag causes ugly skid marks on runways.
c. Drag upsets pilots' nerves.

3. Expander tube brake frames should be inspected every 100 hrs. for cracked or broken torque lugs because . . .

a. Broken lugs should be contributed to the scrap drive immediately.
b. Broken lugs may seriously damage lining.
c. With damaged lugs brake might overexpand.

4. In every 100-hr. check-up, you should pay particular attention to an E. T. brake's retractor springs because . . .

a. Damaged springs cause improper brake pressure release and result in drag.
b. A retractor spring is very interesting.
c. It is important to see if spring is retracted.

5. The condition of the expander tube should be checked every 100 hrs. to . . .

a. Look for any signs of cracking, which would lead to tube failure.
b. See if its air pressure is holding up.
c. Check its basic resilience ratio.

6. Brakes should never be operated when wheel is removed from axle because . . .

a. It's against regulations.
b. It will harden the brake controls.
c. It will cause severe damage and result in brake failure.

7. Specified type of brake fluid should always be used because . . .

a. Wrong fluid might corrode the brake drums.
b. Wrong fluid might have wrong compression.
c. Wrong fluid will cause excessive swelling of rubber parts and result in erratic brake operation.

8. Brakes should be bled for trapped air because . . .

a. Trapped air causes tube oxidation.
b. Soft action will result if not bled properly.
c. Trapped air throws wheels out of balance.

9. Hydraulic fittings, connections, and lines should be checked for leakage daily because . . .

a. Leakage results in poor brake performance.
b. Hydraulic fluid is expensive; we can't afford to let it leak away.
c. Leaking fluid will damage the wheels.

10. Bearing cones and cuffs should be thoroughly cleaned and repacked with grease every 100 flying hours because . . .

a. The crew chief says this is a "must."
b. Any dirt or chips present will cause serious damage to the bearings.
c. Gremlins hang out in the cones and cuffs and must be removed.

WHAT IS YOUR SCORE?

Each correct answer counts 10. 1-b, 2-a, 3-b, 4-a, 5-a, 6-c, 7-c, 8-b, 9-a, 10-b.

This is one of a series of maintenance quizzes prepared for ground crew trainees of the U. S. Army Air Forces Technical Training Command. It is our hope that this series will help all maintenance men get maximum service, safety, and efficiency from military, commercial, and civilian aviation equipment.

B. F. GOODRICH, AERONAUTICAL DIVISION, AKRON, O.

Skyway or Highway

B.F.Goodrich

FIRST IN RUBBER

method, but slight changes in operating conditions may entirely change the picture, and a part that is satisfactory for an airplane scheduled for transoceanic flight may be unsatisfactory for an airplane that is scheduled for transcontinental flight.

It is not generally realized that adequate service records, carefully kept, can prove a most powerful tool in dynamic design. Such service records furnish the information required for checking theories of correlation. Perhaps the best method of presenting service records, even though much chaff must be separated from the wheat, is to furnish actual copies of the airplane's log and of the pilot's log. And, in addition, if continuous stress records are taken against a time base, the pilot's log, in conjunction with weather records, provides a means of correcting the recorded incidence of loading for meteorology and topography.

Given the foregoing information—i.e., adequate flight data, adequate fatigue strength data, and adequate service records—a correlation certainly can be made. Even at the present time, by comparison of a summation curve and of the corresponding "R" curve, approximate evaluations of design can be effected. It is possible to state with assurance that the part under consideration is safe from fatigue failure if the summation curve lies entirely below the high-cycle end of the "R" curve. Likewise, if the "R" curve and the summation curve intersect, the part will be subject to fatigue failures. The problem of design for life expectancy is bounded by these two cases, and, if the corresponding damage curve is available, the comparison becomes more exact and the life span can be roughly estimated.

It may be that, at some time in the future, damage curves can be expressed on a summation basis to give the summation of all combinations of overstress and number of cycles under the curve. Under such conditions the evaluation of life expectancy would be exact. Attention could then be paid to the evaluation of irrational loadings, such as those of Fig. 9e, since such loadings will be expressed as a family of summation curves at constant "R."

As a typical example of damage resulting from repeated loading, a recent investigation[25] may be cited in which a certain structural component was tested under static load and its strength determined. An identical specimen was then subjected to 8,000 cycles of repetitive service loading, after which it was tested statically. It was found that the static strength had been reduced to less than one-half of its original value.

It is the uncertainty arising from insufficient knowledge that makes the fatigue of structural components so insidious a problem. And the aircraft designer must recognize the existence of such uncertainties, not only in control cables, on which the tests described were conducted, but also in many other parts of the aircraft structure.

Conclusion

In modern airplanes and in the airplanes now on the drafting boards, portions of the primary structure, as well as many portions of the secondary structure, do not have infinite service life. The design trends—higher working stresses, lower design load factors, greater speeds—indicate that the condition can be expected to become serious, and a review of the present information on the subjects of fatigue and of service loading indicates that the aircraft designer is currently unable to cope satisfactorily with the problem.

Agencies in foreign countries recognized the situation and initiated research along these lines many years ago. Accordingly, the necessity that this country maintain a leading position in airplane design affords a cogent reason why adequate design criteria must be established, even though the task may extend over several years.

Delay in the initiation of this work will be severely felt in the future. We should not delude ourselves in this matter, since the airplanes of yesterday were not designed to the criteria of the airplanes of today and the airplanes of today are not designed to the criteria of tomorrow.

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The War...And You!

Friend—don't think this war doesn't affect you. It does. It's pushing the world twenty years ahead of time; stimulating the development of devices you may now be making or using. After the war, the average American's life is destined to be fuller, more exciting, more comfortable due to these new products. And just as Weatherhead has helped build the nation's automobiles, airplanes and refrigerators in the past, peace will find us prepared to join you in building these established products as well as the many new ones certain to come out of the war.

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ARMY AIR FORCES TRAINING COMMAND*

Introduction

Like time and tide, American engineering genius waits for no man. Particularly during wartime, the results of its labor issue faster than ever before, thus setting a swift pace for those charged with learning the operation and maintenance of new products. The battle of maintenance rates, alongside the battles of production and combat, equal in difficulty and in importance to victory.

The Army Air Forces have met this challenge by rapidly creating an extensive network of training centers designed to develop mechanics and special equipment operators who can cope with the growing array of armament. These centers receive the recruit after his basic training and graduate him either into the ranks of A.A.F. basic mechanic crews or into advanced schools, exemplified by Chanute Field, Rantoul, Ill., one of the A.A.F.'s largest ground schools. Under the direction of the Army Air Forces Training Command, Chanute Field has become the center of airplane mechanic specialist training and also the site of additional courses, such as machinist, celestial navigation trainer, control tower operation, and others that round out the training program of the A.A.F. Chanute Field was founded as a flying school before the first World War but has been rebuilt and expanded to meet modern war needs. The object of its courses is to develop mechanics and equipment operators who have both a thorough practical knowledge and understanding of technical problems in the field and service shops.

Being comparatively new, aircraft maintenance during a war period cannot depend on finding experienced men to do the work. Mechanics had to be developed by the A.A.F., virtually "overnight," through concentrated courses of study and practice. Courses that once required 2 to 4 years were condensed to a few months of intensive training. At the same time, the material to be covered kept expanding in volume due to the productive efforts of American engineers.

In preparing men for maintenance, the A.A.F. has also had to keep in mind the results of operation in actual theaters of combat. Teaching methods and instructional material had to be revised constantly in view of war experience. Men had to be trained with an eye to peculiarities of the repair and maintenance system set up at and near the front lines.

Maintenance in Theater of Operation

Starting with the general repair depot—one to a theater of war—A.A.F. maintenance organization in the field fans out into a series of Service Centers assigned to areas within the theater. Working in and out of these centers are Service Squadrons, one for each four or fewer combat squadrons at the front. Men from Chanute Field are trained to fill posts in the centers and squadrons, which handle inspection and repair, requiring mobile and light fixed equipment. The Service Squadrons can further extend themselves into their surrounding areas by means of mobile repair units, which can perform work on the spot. Each mobile unit attached to a squadron is comprised of general mechanics, instrument specialists, sheet metal workers, aircraft welders, machinists, electrical and propeller specialists, and others as required.

Equipment and Services

In addition, each Service Center has a machine shop; sheet metal shop; flight section composed of flying mechanics; and electrical, instrument, parachute, and propeller shops. Specialists for these units are trained at Chanute Field. These specialists are directed by the engineering section of the Service Center. There are other sections in a Service Center which are equally important and vital to its functioning, training for which is conducted at other schools. These include the technical supply section, headquarters, chemical warfare service, corps of engineers (which does construction and demolition work), motor vehicle and ordnance sections, quartermaster supply, signal supply and maintenance, medical services, motor transport pool, photographic laboratory, and security department.

Technical supply is charged with the task of furnishing the mechanics with the 150,000 or more different items of equipment, tools, and parts with which they must work. Stock is kept either in permanent or semipermanent shelters or semitrailers.

Motor vehicle and ordnance sections, now combined, are responsible for maintenance of all vehicles used. Ordnance also supplies combat units with ammunition and arms.

The signal supply and maintenance section procures, stores, distributes, and maintains signal equipment such as radio, radar, and teletype. The motor transport pool maintains transport service for various branches of the armed services. The security department is charged with defense against attack.

Mobile units consist of an engineering truck with hoists, machines, tools, supply and personnel trucks, and frequently a trailer for mess equipment. They are capable of wing replacement, engine changes, extensive sheet metal repair, reclamation of planes from water, and numerous adjustments and inspections.

Machine Shops

Service Center machine shops perform all kinds of third echelon work requiring heavy electric power, a wide variety of taps and dies, lathes, milling attachments, and arbor presses. Much of the machine-shop work is the production of special tools and equipment used in repairing. Working with the sheet metal shop, it rebuilds wings, manufacturers cowling and oil lines, replaces damaged carburetor scoops with new ones, and other similar repair.

The sheet metal shop does a wide variety of work, much of it in conjunction with the machine and welding shops. Its men are trained in riveting, repairing Plexiglas, patching self-sealing fuel tanks, and wire splicing, as well as in the regular work of repairing sheet metal and making new sheet metal parts.

The electric shop operates the power and lighting system for the service center, makes conduits, charges storage batteries, maintains radio equipment where necessary, rebuilds damaged circuits in airplanes, and does any other electrical work.

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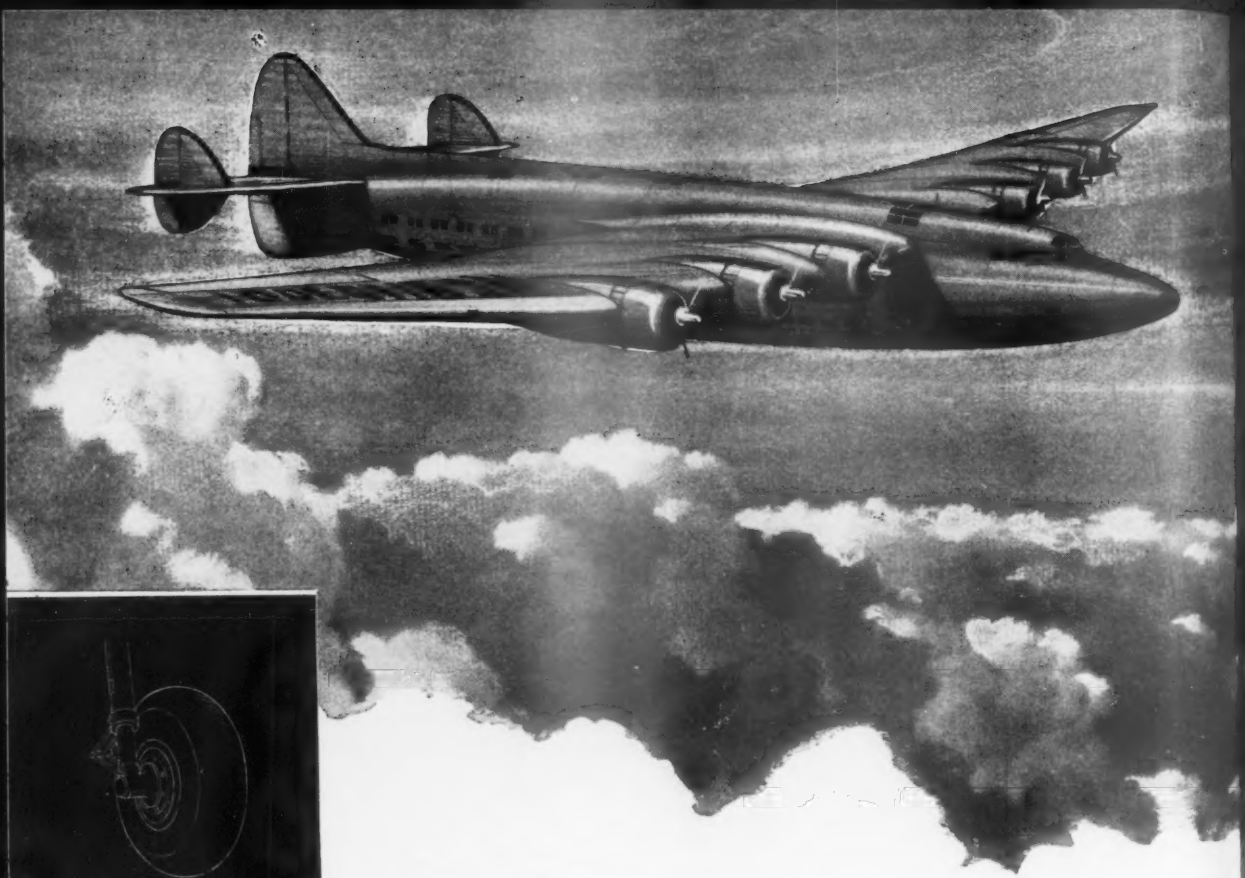
*Prepared especially for the Aeronautical Engineering Review.



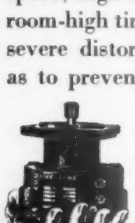
CONVENTIONAL STRUT
is subject to distortion, affecting smooth action.
LEVERED-SUSPENSION
not distorted by impact, brake load, ground speed.

For heavy duty

with the heaviest transport ever built!

Somewhere in a secret hangar, the X-000, first 100-ton plus transport is building . . . with more speed, range and load . . . and more problems, not the least of which is landing.

The conventional landing gear has definite limitations. Obviously the impact of so much weight, the forward speed, high brake load, the inertia of room-high tires . . . would result in such severe distortion of telescoping struts as to prevent the hydraulic cylinders from functioning effectively. So the designers turned to DOWTY.



The pivot action of the Dowty *Levered-Suspension* Landing Gear simultaneously absorbs vertical impact, dissipates horizontal. Strut distortion, bending or flexing cannot affect or diminish the efficiency of the independently placed hydraulic cylinder. *Levered-Suspension* provides certain support, gives a cushion-like landing for any size ship . . . will set down surely and safely any super ship that can be flown.

Proved long before the War, and since tested under combat conditions in many theatres of action . . . the Dowty *Levered-Suspension* Landing Gear and *Live-Line* Pump and Hydraulic System can contribute much to better flying today, to better planes tomorrow.

Our present production, of course, is wholly military. But our research runs far ahead of present requirements, is available for future needs. Our Engineering Department invites your inquiries.

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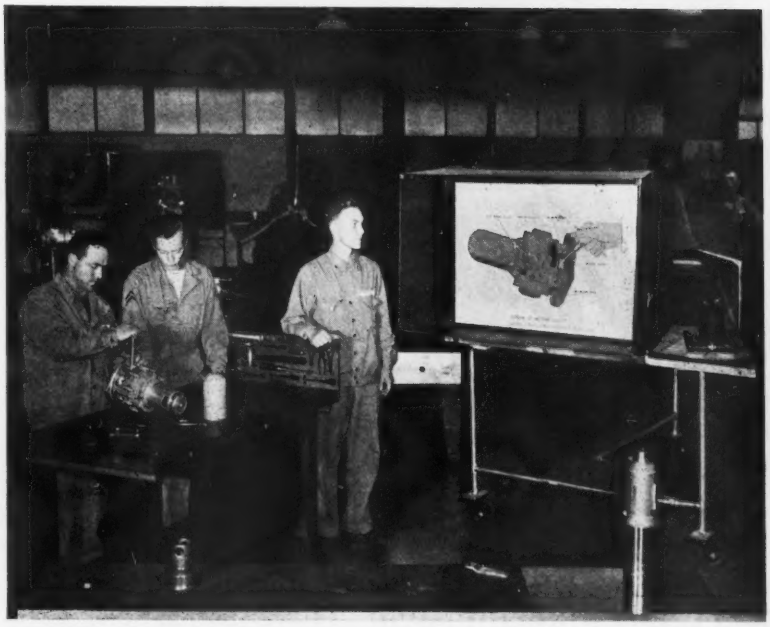
SPECIALISTS IN HYDRAULIC EQUIPMENT & LANDING GEAR FOR AIRCRAFT

The instrument shop tests, makes minor repairs on, and adjusts all instruments found in airplanes. Air-conditioned trailers are often provided to insure proper conditions for working on delicate instruments. It recharges smaller oxygen tanks maintained by combat squadrons.

The propeller shop adjusts, tests, balances, and generally repairs propellers. In addition, it must carry large supplies of such parts as blades with which to replace those damaged beyond repair.

The parachute shop inspects every parachute prior to replacing in service. This includes airing and repacking every 60 days. Third echelon inspection is also performed, consisting of complete repacking, cleaning, repair of parts, and replacement of ripcords on parachutes; inspection of life rafts, vests, and safety belts; and repair or manufacture of turret covers, tail wheel boots, airplane upholstery, navigation kits, flying clothing, and tents.

In view of this complex and extensive system behind the combat lines, it can be seen that the number of men required to sustain aircraft in the air is many times that required to fly them. Despite the increasing technical nature of the equipment to be worked on, A.A.F. educational directors have not seen fit to carry the specialization process to an extreme, believing that to do so would leave a repair unit vulnerable in case a particular specialist was missing.



Photograph by the Army Air Forces Training Command

FIG. 1. Portable daylight projector unit which is used for showing training films and strips in the shop area.

METHODS OF INSTRUCTION

The combat theater system of duties outlined above has a close duplicate in the arrangement of courses at Chanute Field, where there are 17 principal courses divided among five departments. Power Plant, Propellers, Instruments, Electrical and Technical Inspection comprise the Department of Advanced Courses; Machine Shop, Sheet Metal, Welding and Parachutes form the Department of Aircraft Specialists; Teletype and Link Trainers are coupled in a department of the same name, along with Celestial Navigation Trainer courses and Control Tower Operators; Weather is both a course and department, as is also Special Purpose Motor Vehicles.

The trend at Chanute Field over the last year has been toward an almost complete changeover from theoretic lecture-type instruction, designed to give enlisted men a passing familiarity with subject matter involved, to practical work courses aimed at a definite knowledge of job performance. The old lecture system, with its frequent examinations and voluminous note taking, has been supplanted by straight laboratory work based on the idea that showing and doing are better than telling. The time formerly taken by examinations is added to the total laboratory time. Where theoretic matter must be presented in sustained manner, the period for one lecture at a time is strictly limited.

Keynote of the new system is performance. After experimentation with the former system, word came back that many A.A.F. mechanics were unable to remember what they had learned or apply what they knew. It became clear that drill in actual performance was needed to instill proper mechanical skill and enable the student to retain knowledge once acquired. Knowledge, instead of being treated separately from application, was made to accompany it.

Another problem associated with the old system was the dependence of students on full and complete equipment; i.e., lack of ability to improvise. This was corrected through field work without adequate tools. Plans are under way to carry this still further by adding to each course a phase in work under varying weather conditions, which will mean tent camps and more work in actual salvage and repair. To counteract the softening effect of modern quarters and ideally controlled working conditions, it has been found there must be an introduction to the more realistic elements of maintenance work. Students will be given a taste of some of the operating conditions they can expect to find near the front.

The "Job Outline"

An increasing tendency toward standardization of material presented has been in evidence throughout the school, highlighted by the recent adoption of the "Job Outline" system of instruction which has been introduced. Jobs on which students are to be rated are clearly specified in the outline, and study questions are included in order to provoke thorough discussion and understanding. A time element is introduced into these outlines, marking the first time that recognition has been given to the need for rating students according to the period in which they accomplish tasks. The value of such time-incentive training in wartime is obvious.

Personalized Instruction

Each instructor has charge of a small group of men (five to eight) so that personalized instruction can be given. This was made possible by a large instructor-training program through which enlisted men were retained after completing their courses and civilians were brought in as trainees on the same basis. Students work on equipment similar to, and in most instances identical with, that on which they work while in combat areas. Equipment rejected by factories because of minor flaws is marked "for school use" and is used for instructional disassembly and assembly in A.A.F. schools.

Courses are divided into phases, which, in turn, are broken down into well-defined jobs to be accomplished by

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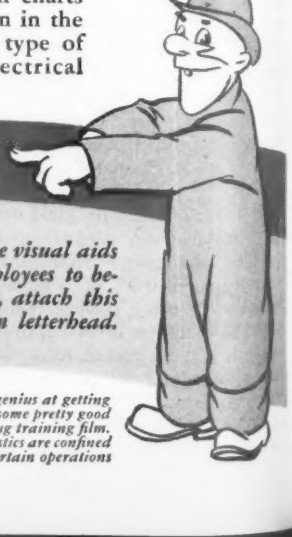


Short-Circuit Sammy is a genius at getting into trouble, but he raises some pretty good questions in the Cannon Plug training film. His pedagogical characteristics are confined to showing how not to do certain operations

students as outlined in the job sheets. Training is on a three-shift basis. New classes are started every sixth instead of every seventh day, so that equipment is kept in use at all times, including the seventh day.

Proper use of tools is stressed by constant practice and drill. Tools are made easily available by being mounted on boards in the immediate working area.

Visual Education

Visual education is widely used in three forms: portable daylight projectors for motion pictures and film strips, which can be wheeled into the work area whenever needed to supplement instruction (Fig. 1); small slide projectors kept in the work area; and full-length moving pictures shown in regulation screening rooms by large projection equipment. The portable daylight projector makes possible the showing of films any time of day, since the image is not seriously affected by sunlight. Colored charts are also used. They are mounted on easels that are placed near the instructional equipment concerned.

The need for instructor improvement was recently recognized by the inauguration of a daily improvement hour during which the latest developments in A.A.F. equipment are presented and questions of instruction are discussed.

The Factory School

An alternative to training as given at Chanute Field is the factory school to which selected graduates of elementary A.A.F. schools are sent to become specialists in a particular make of equipment, thus carrying the process of specialization a step further. Graduates are assigned to various depots and service centers where they aid in work on the type of equipment for which they have been trained. Instructors at Chanute Field are given a similar opportunity, through detached service, to study selected equipment for purposes of improvement as well as special assignment.

So effective has the training program been at A.A.F. schools that reports back from the front lines show less than $2^1/_2$ per cent of all crashes as traceable to faulty maintenance.

In order to understand the exact nature of instruction given at the Technical School at Chanute Field, a study of each course is necessary. A brief description of each follows.

Propeller Course

With the development of the controllable-pitch propeller since 1928, the study and maintenance of propellers and their pitch-changing mechanisms has become a field in itself, requiring elaborate testing, inspecting, and adjusting equipment. Mere installation and removal no longer suffice. Mechanics must understand theory of operation in order to maintain the modern propeller in effective operating condition.

The course of instruction divides propellers into four phases: (1) general inspection, repair, and balancing; (2) hydraulically operated propellers; (3) electrically operated propellers; and (4) governors, electric relays, field work, and troubleshooting on engine test blocks.

In the hydromatic propeller section, a special hydraulic machine feeds the varying oil pressures into the large pitch-changing dome mechanism in order to test complete operation. In the electric propeller department, electrical test sets are used to test the amperage required by the pitch-changing power unit to change blade angles under a severe load. Other types of sets test voltage required to energize relay solenoids, the resistance incorporated into relay resistors, and the continuity of circuits. A cutaway of the entire electric system helps the student see the entire operation as a whole. Students are required to show their understanding of the complete circuit by wiring up all the units in a model system.

Static balancing of propellers is accomplished by running arbors through the central hollow shaft and resting the arbors on parallel mandrels. Practice is given in telescoping—i.e., the reduction of blade length while still preserving the original contour. Nonmagnetic inspection must be performed on nonferrous parts by means of swabbing an area with caustic soda, which will also confirm suspected defects.

In field assembly, work is done on floors without the benefit of special tools or mounting plates. In the hangar, work is done in repair, installation, and removal of propellers on airplanes. On engine test blocks, the action of propellers when in motion is studied, and "troubles" placed in systems by instructors are corrected.

Electrical Course

The electrical specialist in modern aircraft maintenance is given no rest from constant increase in the number of units and systems that he must master. Electricity has replaced other forms of power in the motivation of one system after another in the airplane, until the pinnacle is reached with the modern bomber, which may incorporate as many as 30 different electrical units operated by that form of energy. In addition, the electrical specialist has had to invade to some extent the boundaries of other fields, such as propellers and instruments, in order to correlate his knowledge of complete electrical systems.

Wiring diagrams studied in Chanute Field electrical shops are as large in some instances as 160 sq.ft. and have become so complex that it has been necessary to break them up into units. The field of electronics is also touched to a limited extent by the electrical course—students must understand the maintenance of certain electronic units.

Electricity on the larger planes is used to operate the landing-gear retracting and extending motor; bomb bay doors, bomb location indicators, bomb releases, automatic pilots, various position indicators, flight instruments, engine-operating instruments, propellers, autosyn and other remote indicating devices, starters, generators, magnetos, boosters, including the vibrator interrupter type booster; all types of inverters used for power lines and instruments; power turrets, warning signals, machine-gun synchronization; trim and balance tab controls, landing flaps, torpedo release; portable energizers (gasoline-driven generators); auxiliary gasoline-driven power plants used to start the main engine and as an auxiliary source of power; and the complete lighting systems.

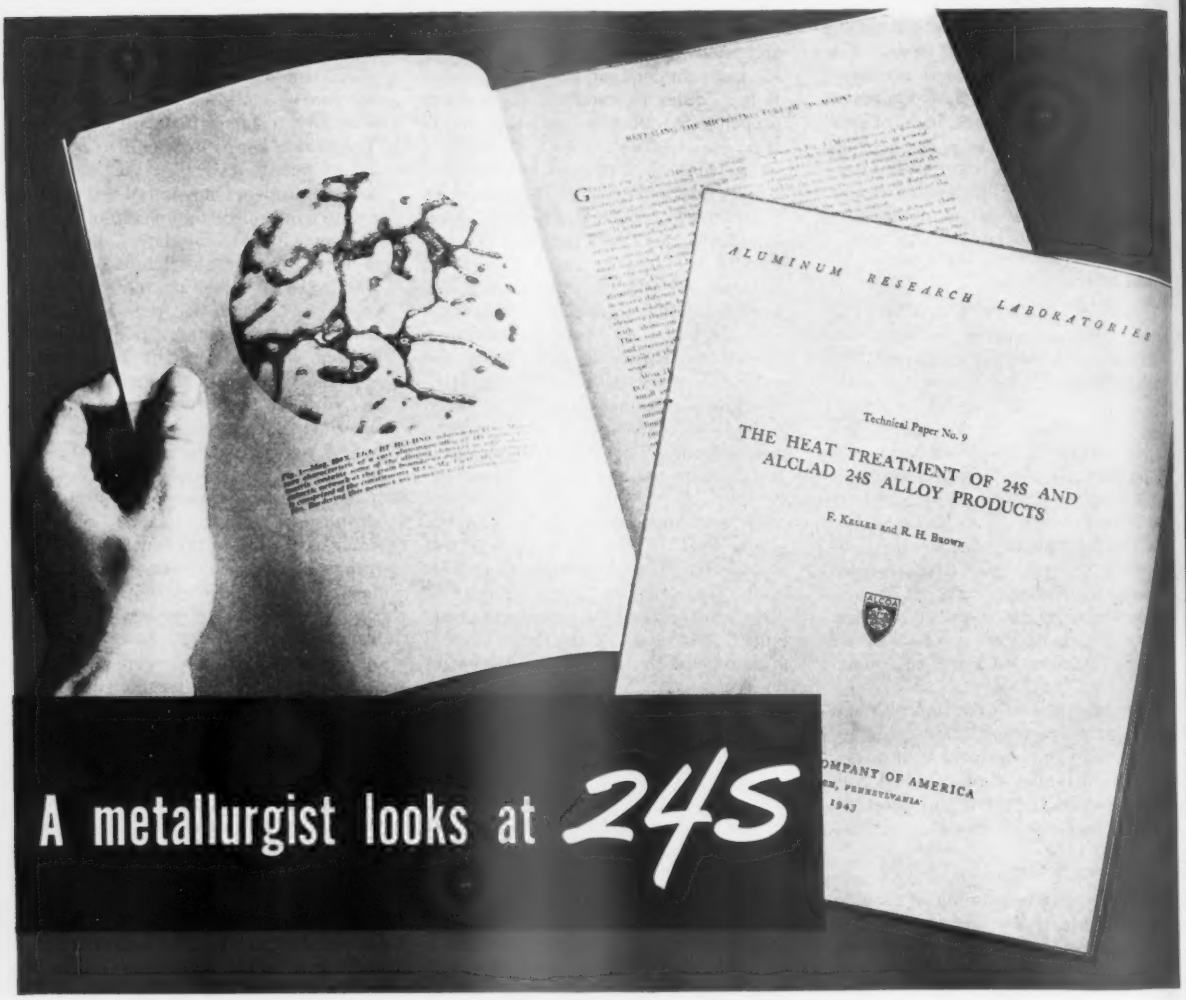
Teaching aids used in this course include the "breadboard" on which various disconnected units are mounted in a single system so that students may practice circuit hookup. These are exemplified by the lighting system "breadboard" shown in Fig. 2.

The use of multiengined planes brought another problem to the electrical department—that of balancing the load on all four generators. This is graphically demonstrated to the student by a four-engined mock-up, which consists of four power units, used to drive four 200-amp. generators, in circuit with the necessary voltage regulators, reverse current cutouts, relays and wiring links to correspond to actual installation on the aircraft.

A recent addition to the course has been the study of methods of supercharging and insulating magnetos and ignition harnesses in order to prevent leakage of current and arcing at high altitudes.

The work of the electrical specialist has been complicated, but the life of the pilot and plane has been lengthened by the elimination of single bus bars. With more than one bus bar and wire for each circuit in the electrical system, the loss of one or the other bar or wire will not incapacitate the circuit.

Students are taught not only how to solder connections on aircraft but how to use, where specified, the solderless crimp connection, which is of comparatively recent development. The technique of taping wires together is also taught, since in many cases shielding has been found unnecessary and too inflexible for combat service.


ALUMINUM RESEARCH LABORATORIES
Technical Paper No. 9
THE HEAT TREATMENT OF 24S AND ALCLAD 24S ALLOY PRODUCTS
F. Keller and R. H. Brown
A metallurgist looks at 24S

Aluminum alloy 24S is used in aircraft construction for parts subjected to high stress; 24S and Alclad 24S sheet and strip for airplane skin and structural members, 24S wire for rivets. Parts made of this alloy are hardened and strengthened by heat treatment.

Technical Papers No. 8 and No. 9, pictured above, tell how you can check the effectiveness of heat treatment. Metallographic methods of examination and the results obtained are outlined. You can detect variations from standard practices by comparing samples taken from your production with those pictured in these papers.

Practices described have been used at Aluminum Research Laboratories and in the industry for many years. When these methods are followed closely, and the proper skill attained, it is possible to determine many pertinent facts about 24S from metallographic examinations. Your metallurgist should have these two booklets.

For copies of Technical Papers No. 8 and No. 9, write ALUMINUM COMPANY OF AMERICA, 2142 Gulf Bldg., Pittsburgh, Pa.

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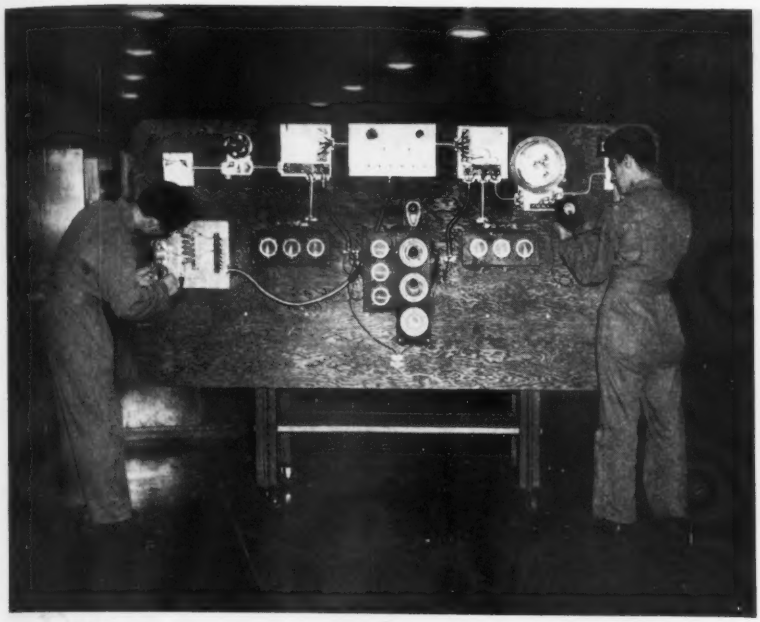


Photograph by the Army Air Forces Training Command

FIG. 2. Working on an electrical system with its units spread out plainly on a "breadboard" greatly facilitates the study of circuits by the electrical specialist student. Shown above is a mock-up of the external lighting system of the average airplane, including recognition, formation, landing, passing, and running lights.

Emphasis is placed in the electrical course on the sources of current—battery, generator and their immediate accessories—because such a large share of troubles experienced is caused by these units.

Magneto-to-engine timing is a function of the electrical rather than the power-plant specialist; thus engines are mounted in the electrical department for student practice in this work. Use is made of the top center indicator, timing disc and pointer; and the Abbott A-100 synchronizer timing light. Students must also learn magneto-to-engine coupling and mounting, using direct and Sims methods.

Armatures are thoroughly studied as to methods of winding, field assembly, brush assembly, and end bell assembly. Types of voltage regulation, the operation and maintenance of generator test stands, and auxiliary generators are also studied.

Spark plugs must be installed, cleaned, adjusted, and tested by students. Dynamotors and alternators must be inspected for wear, cleanliness, and output.

The electrical load on the airplane has increased until at the present time some aircraft have a generator load of 800 amp. at 28.5 volts when operating at full capacity. Under partial load the control of the generator presents a difficult problem to the electrician. Training of the specialist is designed with an eye toward enabling him to name the cause of a trouble from surface indications without a major overhaul. He is trained as an analyst, as well as a mechanic, and often depends on general mechanics to help him in his physical work.

INSTRUMENT COURSE

An instrument specialist on the maintenance crew of large modern airplanes must have knowledge of the operation and repair of more than 30 different kinds of instruments. He also must keep abreast of the constant changes in mechanisms devised to operate each type of instrument. For example, the double bellows is replacing the single aneroid in the manifold pressure gauge, the remote indicating compass is replacing the magnetic compass, and the electric gyro is replacing the air-driven gyro. He must know not only electricity but pressure systems, vacuum systems, Bourdon tube actions, and gyroscopic principles.

First Phase of Study

Initiation of the student into the first phase of the instrument course, which deals with the pressure group of instruments, requires the study of atmospheric pressure, the barometer, manometer adjustments, reading of scales, scale corrections, action of liquids, tubing connections, and bench testing procedure in measurement of absolute and differential pressure. The student is taught the principles of operation, operating mechanisms, care, maintenance, and installation of the pressure gauges. He is given practice in the technique of testing for errors such as scale error, position error, friction error, and errors due to case leaks.

For example, after the student has given an air-speed indicator a scale error test and after he has tested for position error, friction, and case leak, he plots a curve of the detected errors. He is then taught to diagnose the troubles in his instrument with the aid of this error curve. After the errors have been analyzed he is taught how to correct these errors and adjust the instrument.

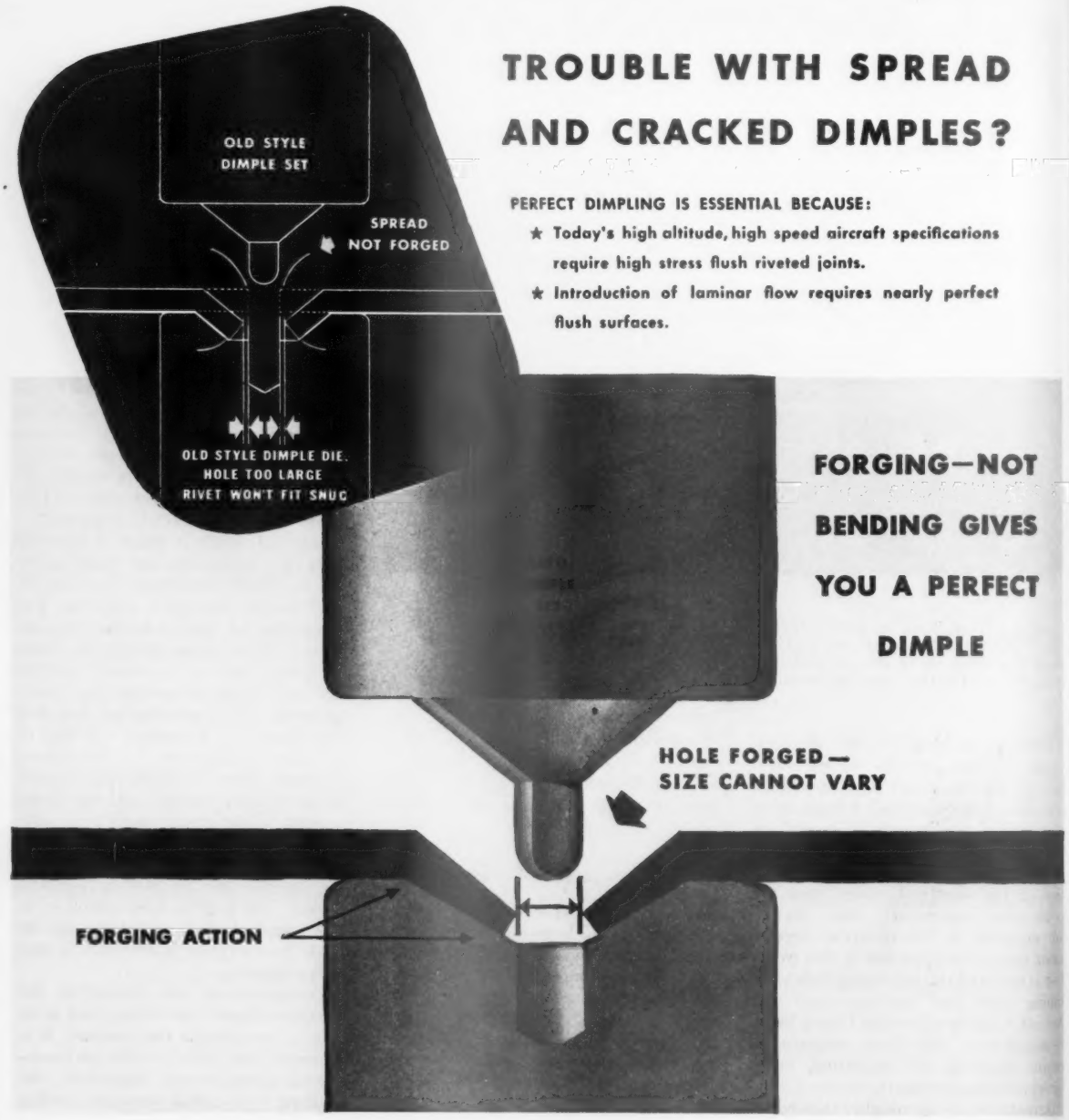
Second Phase of Study

During the second phase of the instrument course the student becomes familiar with electrically operated aircraft instruments. He is taught the fundamental laws of electricity and how these laws apply to electrical instruments. A study is made of the construction, operation, and maintenance of electrical measuring instruments, such as the voltmeter, ammeter, and ohmmeter, as applied to electrical circuits. Working mock-ups are built in such a way that common troubles are put in the mock-ups and the student practices the application of this test equipment to determine whether or not the instrument is functioning properly. For example, the student tests for proper voltage, resistance, and current in the instrument circuit with the common instrument test equipment and also receives training in testing instruments with the Station Electrical Tester. He is given information as to how simple testing equipment can be made from airplane instruments in case of emergencies.

Compasses are also studied in the electrical phase. For the student to be able to compensate the compass, it is necessary that he understand the fundamental principles of magnetism, the meaning of deviation, variation, heeling error, and northerly turning error. The newer types of compasses require the application of electrical principles in the remote indicating systems in addition to the usual magnetic principles. One student practices swinging and compensating the compass by the swinging base method and by the sighting method. He compensates by the newer coefficient method which employs a series of formulas to determine the correction needed for constant, semicircular, and quadrantal errors.

Upon entering the next phase the student is introduced to precession and rigidity, which are the underlying gyroscopic principles of the flight instruments and the automatic pilots. He is trained to bench-test and diagnose the troubles encountered in the three flight instruments. This bench-testing

TROUBLE WITH SPREAD AND CRACKED DIMPLES?


OLD STYLE DIMPLE SET
SPREAD NOT FORGED
OLD STYLE DIMPLE DIE. HOLE TOO LARGE RIVET WON'T FIT SNUG
FORGING—NOT BENDING GIVES YOU A PERFECT DIMPLE
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includes the use of the Scorsby base (Fig. 3) used in testing directional indicators and flight indicators, the motor-driven turntable used in testing the bank and turn indicator, and a special test stand for simulating flight conditions used in testing the flight indicator.

The student is given practice in trouble shooting on hydraulically operated and electrically operated automatic pilots, in addition to being taught how to install and service these pilots.

Up to this point in the course, the student has studied and used shop equipment. He is now qualified to use field test equipment. After a brief introduction to the use and maintenance of the C-1 Field Test Set, where he practices the use of the test set on mock-ups in the laboratory, he is sent to the hangar to work on the instruments installed in airplanes. The student is expected to determine from these tests whether or not the troubles he finds are in the instrument or in the installation. Should the trouble be in the installation he remedies it without removing the instrument from the plane. However, should he find that the trouble is in the instrument, he removes the instrument and proceeds to test and repair it as he has been trained to do during the earlier phases of instruction.

In training first and second echelon instrument specialists for line duty, the instrument division keeps four practical maintenance objectives in mind: (1) principles of operation and operating mechanisms; (2) field and bench testing: (3) diagnosis of troubles; and (4) repair and adjustment.

Power-Plant Course

Despite the sturdiness of modern aircraft engines, their maintenance is largely a problem in precision care. Slight out-of-adjustments can spell the difference between a smoothly functioning system and one that fails in crucial moments of flight.

For that reason the exact measurement of clearances, the proper methods of valve and ignition timing, and the dynamic balancing of vital moving parts are stressed throughout this course. The very intricacies of an aircraft engine make it a fertile source of troubles; therefore, considerable time is spent trouble shooting in an effort to anticipate all possible occurrences. The power-plant course is a study in "preventive maintenance."

Disassembly

Disassembly is performed down to pistons, cylinders, crankshafts, manifolds and cooling baffles, which are examined for indications of wear and are repaired if necessary. Cleanliness is emphasized along with proper lubrication, installation of numerous gaskets and packings, and the safetying of all bolts, nuts, and other parts.

Turbosuperchargers are disassembled, and their bucket wheels and impellers are carefully balanced on a dynamic test stand (Fig. 4). An unbalance of ounces would exert a centrifugal force of thousands of pounds because of the high speed of rotation. The regulator assembly and intercooler system used in connection with superchargers are inspected, serviced, and repaired. Operation at high altitudes is studied by controlling the flow of air into the supercharger, thus simulating high-altitude conditions.

Photograph by the Army Air Forces Training Command

FIG. 4. The balance of a supercharger impeller wheel and turbine is checked by this student on a special stand designed for the purpose.

Electrical Equipment

While adjustment of the ignition, starting and battery-generator systems is properly the function of the electrical specialist, the power-plant specialist must also know these parts—including magnetos; spark plugs; ignition harness; boosters; switches; starters; solenoids; the generator control panel, with its voltage and current regulator and reverse current cutout; and the synchronization of multi-engined generator systems.

Fuels

Every aspect of fuels is studied, from fuel strainers to warning signals, vapor eliminators, and relief valves. Carburetors, known for their need of frequent adjustment, are thoroughly studied. The entire oiling system is traced through, inspected, and adjusted.

Trouble Shooting

To facilitate trouble shooting on the live engine test block, methods are devised for the systematic diagnosis of power-plant difficulties. Students are required to list all possible causes of a trouble placed in the engine by the instructor before being permitted to discover and correct the actual cause.

Photograph by the Army Air Forces Training Command

FIG. 3. The instructor uncages the direction gyro control box on the A-2 automatic pilot mounted on the pivot of a Scorsby base. This is done in preparation for a demonstration of the manner in which the base simulated various attitudes of flight and tests the reactions of the instruments to them.

Here's an Aircraft Instrument that never leaves the ground

In hundreds of control towers guarding America's forty thousand miles of skyways, Kollsman altimeters are vital "reference points" for planes in flight. Pilots radio these towers for "the Kollsman"—the barometric pressure setting shown by the station altimeter. The pilot's own Kollsman altimeter is then set to correspond—a procedure vital to maintaining airway traffic flight levels, and in making safe landings. The first commercial sensitive altimeters were products of Kollsman research—20 times more sensitive than then existing types. Since then—on the ground and in the air—they have become the standard of safety and reliability in the operation of American aircraft.

WHAT TOMORROW'S AIR TRAFFIC PROBLEMS *will be we do not yet know. But we do know that instruments will play a large part in their solution and in expanding the scope and usefulness of the airplane far beyond anything we know today. Kollsman engineers are constantly developing new and better aircraft instruments which will help widen and extend tomorrow's skyways.*

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Engine Removal and Installation

Because a major part of their work will be engine removal and installation, a special phase of the course is devoted to these two procedures alone. They involve, of course, the removal and installation of not only the engine but also the propeller, spark plugs, fairing, cowling, drainage of oil, fuel and coolant; proper disconnection of manifolds and electrical heater connections; and loosening of all attached parts before finally hoisting the engine from the airplane.

Accessories such as carburetors and their heaters, hydraulic pumps, tachometer generator and adapter, generator, vacuum pump, starter, oil filters, propeller governors, and mounts must also be removed and reinstalled as part of the training. Special attention is given to the proper method for preparing the engine and its accessories for storage. Nor does mere reinstallation suffice to complete the phase; parts reinstalled must be tested and inspected and flexible connections must be tightened to the specified degree. The entire 50-hour inspection is accomplished.

The final test comes with actual engine operation, which tests the operation of the engine, the throttle, mixture control, propeller, fuel cocks, primer, supercharger, oil temperature and pressure, fuel pressure, coolant temperature, electrical continuity and proper connections, hydraulic pressure, correct vacuum readings, cooling flaps and shutters, and oil dilution.

Technical Inspectors Course

Because of the great expansion of the Army Air Forces which has taken place since Pearl Harbor, many of the new units that were activated found themselves without qualified personnel to carry on the important function of technical inspection. For this reason, the Technical Inspectors Course at Chanute Field was established.

The purpose of this course is to teach especially selected officers and enlisted men the procedure in the performance of technical inspections of A.A.F. technical equipment, facilities, and policies, as well as the use of all A.A.F. publications of a technical nature. The technical inspector's responsibility is to make certain that all inspections called for by Technical Orders are properly carried out by the aircraft mechanic and those charged with maintenance of permanent equipment at a station or air base. Technical inspectors may be attached to squadrons, groups, stations, or air bases, area wing staffs, air forces, or, finally, the Air Inspector's Office in Washington.

The personnel selected for this training are required to have had a considerable amount of technical training prior to their being sent to Chanute Field for this course of instruction.

During the course of instruction students are required to familiarize themselves thoroughly with all regulations affecting A.A.F. technical equipment, facilities, and policies and are also required to conduct actual technical inspections of all items as shown in the Technical Inspection Manual. Upon completion of any inspection each student is required to prepare a report covering the item or items inspected in accordance with the provisions of A.A.F. Regulations. These reports are complete in every detail and, in general, are prepared in the same manner as they would be were the inspector conducting an inspection at his own station.

Basic Training for Machinists, Sheet Metal Workers, and Welders

When preparing men to perform any mechanical work there is a certain amount of fundamental training that they must have. This training includes the Army Air Forces Maintenance Systems, Mechanical Drafting and Blueprint Reading and Elements of Shop Work.

Upon completion of this training, the student is ready to progress to the welding, sheet metal, or machine shops where he receives further intensive training, which is described under the heading for these courses.

Army Air Forces Maintenance Systems is the first phase of the basic training. In this course the primary purpose is to teach the students the various sources and filing systems of technical information which pertain to the servicing and repairing of aircraft. A good maintenance man would not be expected to learn and remember all of the techniques of skilled aircraft maintenance as performed by the Army Air Forces, but he must know where such information may be quickly and accurately found. Also taken up at this time are safety precautions that pertain to shop and hangar work.

Mechanical Drafting and Blueprint Reading

Mechanical drafting and blueprint reading is the second phase, and the primary purpose of this course is to teach the students the language of mechanics, which is blueprint reading. A shopworker is seldom given detailed verbal instructions as to how he should perform a job, but he is usually given a blueprint and told to manufacture a new part or repair an old part so that its dimensions are the same as a new one. It is therefore imperative that these men be able to visualize what a finished part looks like by looking at the blueprint. The men are taught how to visualize by the use of "The Glass Box." An object is put into the box; the top, front, and end views are traced on the sides of the box; and then the box is unfolded and the views are the same as in a blueprint. After several demonstrations the student is given blocks to see if he can make orthographic projection drawings of them. He is then given blueprints (orthographic projection drawings) of objects and an assortment of pictorial drawings (isometric views), and he is required to match them up. These blueprint reading exercises are started out with fairly simple objects and they become more difficult as he progresses through the course. Along with the blueprint reading exercises he is also taught the meaning of symbols, representations, and sectional views. Limits and tolerances are covered when taking up dimensioning.

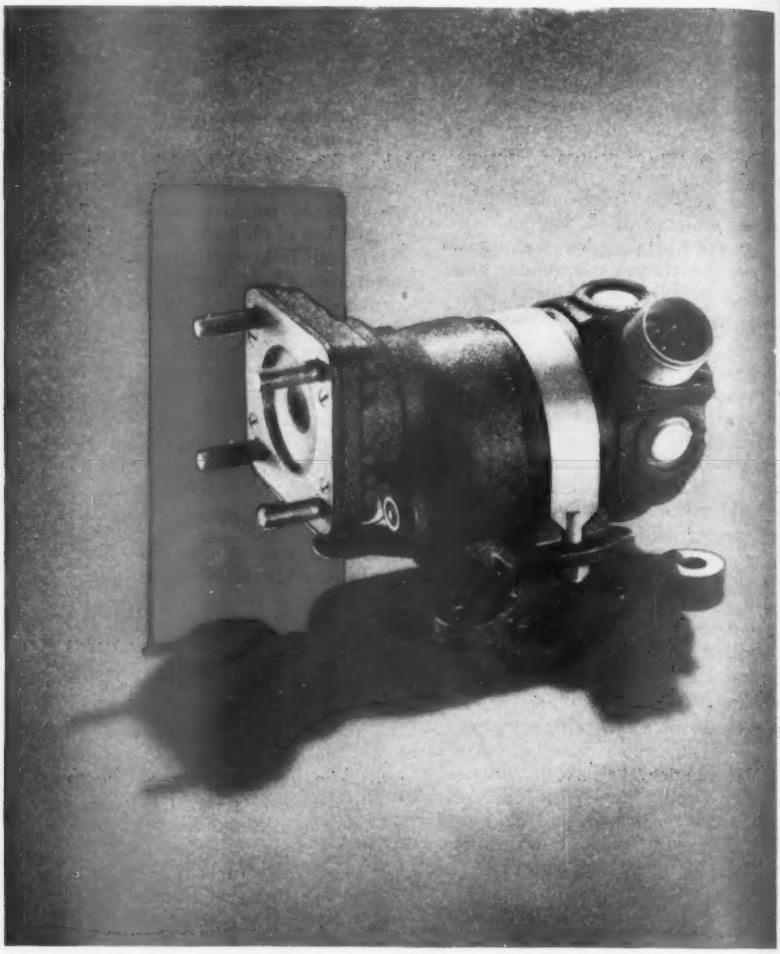
A limited amount of development drawing is covered so that the student can lay out patterns for sheet metal work.

Shop Work

Elements of shop work is the third phase of the basic course. The purpose of this course is to make of every student a "handy man," thus enabling him to perform general maintenance that can be performed with hand tools. This is accomplished by teaching them the care and use of hand and basic power tools and also measuring instruments.

The instructor takes a small group of students and gives them a complete demonstration on how to lay out the work, the actual step-by-step performance of work, and the checking of the accuracy of the work. He supplements his demonstrations with mock-ups, large-scale drawings, sectionalized drawings, film strips, and talking movies. The student then proceeds to do the work as outlined in job sheets, and he is under the constant supervision of an instructor. He learns how to lay out the work on the metal, how to saw (hand and power), how to file (cross, drawn, and radius), how to drill (straight and angular), how to grind drills, and how to ream, tap, and thread. Measuring tools of all types are taken up and the vernier and micrometer caliper are gone into in detail.

It is in this phase of the work that the student is made aware of the fact that accuracy rather than speed is the theme of the work of the aircraft specialists. A poor piece of work is never passed; however, if the man does good work but is slow, he will be carried on as a student. He can learn to do the work at a faster speed after he has done a certain amount of line work.



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Aircraft Machinist Course

If modern combat units had to depend entirely upon the ready-made equipment they possessed, with their specialized, interdependent parts, a slight defect might easily render an entire airplane or other tactical unit inoperative. Therefore, it is evident that the A.A.F. must have machine shops and trained machinists handy to the front lines. At this writing they are used as far forward as the service centers—one step beyond the general depot—easily available to the service squadrons that do most of the maintenance work during and after combat missions.

Machine-shop specialists must be able to manufacture new parts when and as needed, thus making the service squadron less dependent upon the services of supply. These specialists, operating their miniature factory, can also do immediate repair or replacement in connection with repair and can construct special emergency tools needed by other specialists.

Like the other two metalworking courses at Chanute Field, welding and sheet metal, the machinist course begins with a basic phase, whose function has already been outlined above.

Use of Machine Tools

After successful completion of the preliminary training, the student progressively completes training in the operation, maintenance, and use of machine tools, such as the lathe, milling machine, shaper, drill press, contour saw, and precision cylindric and surface grinding machines. He is required to finish a considerable list of projects which develop technique. The machinist course, which lasts 102 academic days, is the longest in the school. Two hundred and sixteen hours are spent on lathes alone, covering lathe nomenclature; care and use of lathe tools and chucks; speeds, feeds and r.p.m. calculations; radial turning and facing; A.A.F. markings and specifications of metals; grinding and aligning centers; and machining reamers, keyed shafts, thread taps, recessing mandrel centers, turning radii, knurling, drill grinding, gearing, tapping, and die threading.

Under milling-machine operation, the student learns 44 different types of work from indexing to slotting a socket wrench, fluting taps, fly cutter boring, and stub tooth gearing.

The use of contour machines (Fig. 5), which is gaining in application and popularity, is stressed, particularly because of its versatility and ability to perform rapid work on odd shapes. On contour machines the student learns types and use of file bands, filing and polishing, feed attachments, and stack sawing.

Photograph by the Army Air Forces Training Command

Fig. 5. The Do-all type of contour saw being used by a student to make a "C" clamp for holding work on tables. At the right are tools fabricated on this machine.

A myriad of uses for the shaper and planer are taught, ranging from planing shoulders to internal keyways. On grinding machines students cover numerous operations from a variety of elementary types of work to the finest of precision grinding where they are held to 0.0005 in. tolerances. This work, ordinarily entrusted by factories only to their oldest and most experienced man, is made part of the course given to students.

One of the aims of the course is to introduce the student to the versatility of machines and their various attachments in order that a variety of work can be done with limited equipment if necessary.

Heat-Treating

To round out the program of the course, a phase is devoted to the subject of heat-treatment, including annealing, normalizing, hardening, hydrizing, tempering, cyaniding, carburizing, and nitriding. The student learns the maintenance of heat-treating equipment and how to check the results of his heat-treatment on metals, using the Brinnell and other tests. He is also shown how to check for tensile strength. Heat-treating jobs given to students to perform include the annealing of ferrous and nonferrous metals; normalizing of ferrous metals; hardening of ferrous metals and giving nonferrous metals the aging treatment; and tempering and carburizing ferrous metals.

With the hydrizing furnace students are able to control the atmosphere, thus making it especially suitable for high-speed steels where decarburization must be prevented.

For use in emergencies (which covers a major percentage of the time in combat areas) students are taught how to do minor heat-treating with an oxy-acetylene torch, chiefly on ferrous metal.

Plans are under way for a model trailer equipped with standard machinists tools and machinery so that students will have practice in working under conditions more similar to those in the field.

In the training program particular emphasis is placed on manipulative skill. Accuracy and quality are stressed rather than speed, and tolerances are held closer than would be necessary in actual practice so that accuracy will become a permanent part of the students' work habits.

Welding Course

Since the modern airplane is constructed largely of metal and welding is often the fastest and easiest portable means of joining metals, it is necessary to train specialists in this type of work. As a repair tool, modern welding equipment in the hands of a skillful operator is unsurpassed. This applies not only to the airplane itself but to the ground equipment as well.

Gas Welding

In his progress through the welding course, the student first learns the fundamentals of gas welding—how to set up and close down a portable welding outfit—and gets many hours of practice in making simple welds. He learns how to set up the work, the selection of proper size of filler rod and torch tip, and the different techniques required in working with the various aircraft metals. Each student is assigned a welding job and given instructions for accomplishing the job. When he can demonstrate his ability to do this particular weld in a satisfactory manner the instructor assigns him to another job. In this manner the student progresses from the simple to the more complex welding techniques. Included also is practice in silver soldering, brazing, and cutting with the oxyacetylene torch.

Electric Arc Welding

Next the student learns to weld by the electric arc process, starting with the fundamentals, learning how to strike and maintain an arc, then making the various types of joints, according to schedule, all in the flat position. When he has acquired sufficient skill to be able to produce good work he is advanced to "position welding," where he learns to make the same types of joints as before except that they are in the vertical and overhead positions. A short time is spent in becoming acquainted with the resistance welding process, during which he is instructed in the operation of a modern spot-welding machine. Toward the end of

this phase the student is given a qualification test covering welding in the different positions. Specimens are cut from the joints that he has welded and are tested for tensile strength (Fig. 6) ductility, etc.

The student is next assigned to the heat-treating phase where special emphasis is placed on the effect that welding has on the various parent metals with regard to their tensile strength and other physical properties.

The last phase of the course is aircraft welding where practically all the work performed is on actual aircraft parts such as engine mounts, cowlings, exhaust manifolds, and aluminum- and magnesium-alloy castings. The student makes repairs and finishes the part, making it ready for use. Before completing the course, the student is given a qualification test that is designed to test his ability to perform first-class work. He makes welds in various positions and each one is tested either in the tensile testing machine or by sawing through the weld and etching.

Photograph by the Army Air Forces Training Command

FIG. 6. Strength of welds is checked in this tensile-testing machine as part of the welding course.

AIRCRAFT METALWORKERS COURSE

Every time military aircraft enter into combat and any damages occur, the metal-skin or plastic coverings always bear the brunt of the damage. Add to the above the damages to the radiators, oil temperature regulators, plumbing lines, cables, structural reinforcing members, and general field maintenance work, and the tremendous need for aircraft metalworkers becomes obvious.

First taught are the care and operation of the special sheet metal tools and machines and how to select the proper metal, lay out metal patterns, and construct sheet metal articles needed in field maintenance. Instruction is given in the emergency and permanent repair of tubes and tanks of the radiators and oil temperature regulators. Such repairs are made on face seam leaks and on tube leaks requiring replacement or the plugging of tubes. Tubes are removed with a torch, tube cutter, and push rod or with a special soldering copper. The various types of aircraft cables, such as the 1 by 19 nonflexible, the 7 by 7 flexible, and the 7 by 19 extra flexible, are spliced. Terminals are made using the five-tuck navy splice, the wrapped and soldered terminal, and the sweat soldered terminal.

Repairs

Instruction is given in hand and machine methods of bending aircraft tubing, flaring, attaching fittings, and in making the different types of tubing repairs. Students are shown how to identify and select aircraft rivets and to rivet by hand and with the pneumatic and squeeze riveters. Experience is acquired in the use of blind rivets such as the Cherry rivet, the explosive rivet, and the Goodrich Rivnut. The installation of sheet metal screws, self-locking nuts, and Dzus fasteners is also practiced.

Identification, inspection, handling, storage, and testing of self-sealing fuel cells are taught. The cells are actually removed, repaired, and reinstalled during the course. Both emergency and permanent repairs are made on the cells.

Transparent plastic sheet, such as is used in combat aircraft, is cleaned, repaired, formed, and installed.

Sheet Metal Work

The properties and uses of aircraft sheet metals, especially the aluminum alloys, are studied. Instruction is given in working these metals by bumping with sandbags, wooden forms, and metal dies; in stretching and shrinking flanges; and in bending on machines. Experience is gained in making the calculations for bends and in making the actual layouts on the sheet. Actual aircraft repairs are made, beginning with simple nonstressed skin repairs and progressing to the accomplishment of complicated combination repairs involving stringers, webs, and stressed skin, requiring heat-treatment and numerous forming operations.

PARACHUTE RIGGERS COURSE

The parachute rigger is responsible for the proper care and maintenance of the parachute upon which the pilot and crew must depend in the event of aircraft failure. His duties also include the repair and maintenance of flying clothing, goggles, and pneumatic equipment.

When the student enters the course, his first reaction is one of shock upon being confronted with sewing machines. But he soon learns why the sewing machines are there. In a short time he will be fabricating covers, bags, life-preserver cushions, airplane upholstery, and flying clothing to familiarize himself with the construction of Army Air Forces equipment. He will be attaching organization and rank insignia to flying clothing, repairing parachute canopies, and machine sewing parachute harness at the links that connect the harness to the suspension lines leading from the canopy.

Under actual combat conditions sewing machines are not always available for the parachute rigger. Hand sewing is being stressed as a substitute for machine sewing and as a substitute for grommets or eyelets for reinforcing openings in fabric materials. One of the frequent tasks of the rigger is to hand repair tears on flying clothing manufactured from sheep shearling. It may even be necessary for the rigger to darn small snags in parachute canopies or replace the rubber retainer bands that hold the suspension lines to the bottom of the parachute pack with retainer pocket loops of fabric.

Inspection and Maintenance

In order that the parachute may remain serviceable as long as possible, regular inspection and maintenance schedules have been established by the Army Air Forces. Visual routine inspections are required every ten days in which only the exterior of the pack and the harness are examined. A complete inspection involving the opening, drying, and repacking is made every 30 days in the insular possessions of the United States and every 60 days for parachutes in domestic service. These inspections are made by the student rigger on the seat, back, attachable, and quick attachable chest types, which are most commonly used by the Army Air Forces. Besides learning how to pack these various types of parachutes under normal conditions, the student receives instruction in methods of emergency packing under tactical conditions.

It is the responsibility of the parachute rigger to adjust the harness of each parachute assigned to flying personnel so that it fits snugly to prevent serious harness burns or other bodily injuries in case of an emergency jump.

For jungle and polar areas specially equipped back pads are designed to replace the regular types. The student rigger learns to check and inspect the contents of these emergency kits that are designed to sustain life under the most adverse conditions. Some of this equipment includes the compass, a vial of iodine used for disinfectant and

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One of the most significant aspects of the contributions of the aircraft industry to our country's war effort, has been the exchange and utilization of specialized abilities on a cooperative, intra-industry basis.

At McDonnell, we have been privileged to work with the Army and Navy, and with a number of aircraft manufacturers on assignments involving specialized research.

Detailed information concerning the results achieved by our engineers, is of military necessity, restricted. We can, however, mention a few among many projects brought to successful completion.

Among these were: an *aerodynamic research* assignment on a well-known combat plane which has seen action in many engagements; a *flutter research* assignment on a giant plane being built by one of America's largest aircraft manufacturers; the *development* of strong, lightweight *plastic ammunition boxes;* and the *redesigning* of *gun turret parts* to permit the use of weight-saving plastic.

We are prepared to carry out further research assignments—with particular reference to *flutter research,* and the *development* and *use* of *plastics* in many phases of aircraft design and manufacture. We shall welcome inquiries.

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AMERICA'S Victory fleets of aircraft, ships and tanks are on their way, roaring full speed ahead in the vanguard of invasion toward the goal for which we all are fighting. Serving aboard these battle units of land, sea, and air is the vitally important equipment that Breeze is producing today in constantly increasing quantities. Such products as Breeze Radio Ignition Shielding, Multiple Electrical Connectors, Flexible Conduit and Fittings, Aircraft Armor Plate and Cartridge-Type Engine Starters are but a few of the many items in the Breeze line that are playing their part on fighting fronts the world over. Performing dependably under the grueling conditions of modern warfare, all Breeze products possess the built-in quality that reflects a background of many years of Breeze engineering and production experience.

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water purification, matches, quinine as a protection from malaria, emergency rations, and fishing equipment.

Flotation Equipment

One of the important duties of the rigger which the student must learn is the inspection and maintenance of all types of flotation equipment, including the B-4 "Mae West" life vest, which are used in flights over bodies of water. He is taught the different types of rafts (Fig. 7) in order to equip them properly with the accessories each must contain so that occupants may survive an ordeal of days or even weeks. Bullet-hole plugs, pyrotechnic pistols and flares for signaling, emergency rations, drinking water, fluorescein dye used as seamarkers, bailing buckets, and paddles painted a light blue so as not to attract sharks are some items of equipment stowed in these rafts. In connection with the accessories for some of the larger type rafts, homing pigeons and a radio set are at times issued to and carried in the aircraft. It is his duty also to make the weight checks on CO_2 cylinders so that over or under expansion will not peril the safety of those using the raft.

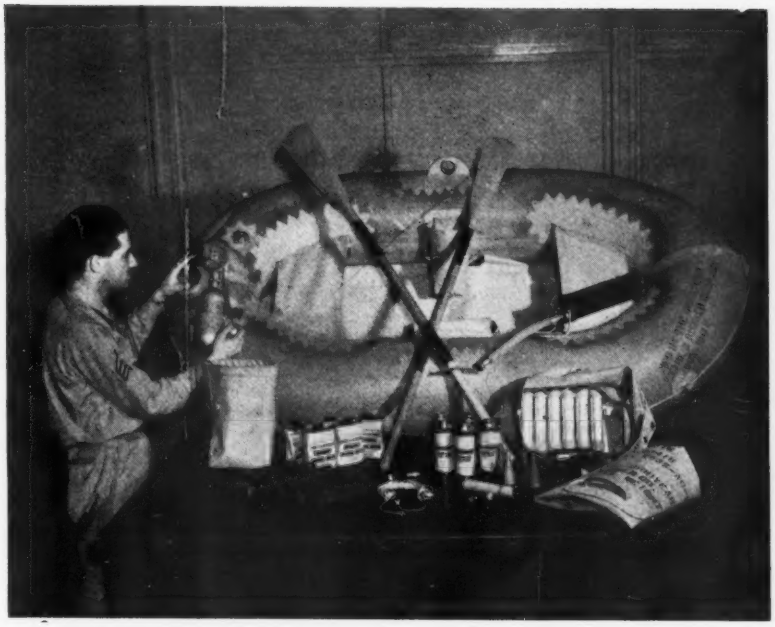
One of the most recent additions to the parachute riggers course has been the inclusion of cargo parachutes and an enlarged variety of aerial delivery units. Types that will land equipment ranging up to 3,000 lbs. are studied, packed, and inspected. Cargoes for these parachutes may be anything from a can of milk up to light tanks and jeeps.

Link Trainer Instructor Course

The airplane itself is not the only thing that must be maintained by the Army Air Forces in order that aerial combat be effective. The pilot must also be "kept" in condition. For this purpose a synthetic instrument trainer is used. In addition, flying cadets or students can be taught the principles of flight before actually setting foot in an airplane. Through the use of this trainer, instrument flying and refresher courses can be taught to flying officers and cadets without endangering life and property in actual aircraft.

The trainer is a miniature airplane on a universal joint. It is fully equipped with controls, flight instruments, control surfaces, and radio aids simulating equipment. Many subjects in allied fields, such as instruments, navigation, radio, and meteorology, must be studied in order to understand the operation of the trainer.

Graduates of the course are assigned to Army air bases throughout the world, where they train flying officers and cadets.



Photograph by the Army Air Forces Training Command

Fig. 7. Complete maintenance of all items on the life raft is the duty of the parachute specialist, shown here adjusting the CO_2 cylinder. Left to right on the raft are the oars and the hand pump. On the table are the bailing bucket, emergency field rations, drinking water, oar locks, test cord, fluorescein sea marker, patching kit and bullet hole plugs (in front of sea marker), flares and pyrotechnic pistol, and the case in which the entire raft and accessories may be packed.

Trainer Instruction

While the student is seated in the cockpit of the trainer with the hood closed, the instructor, seated at the control desk, gives him radio beam signals, watches the automatic recording device tell the exact results of the student's operations, and occasionally freezes the entire mechanism in position when it is necessary to catch and correct a mistake "in the process." The advantage of the recorder is that it keeps a permanent record of the trainer's "flight" so that the student as well as the instructor can study it.

The course begins with instruction in maintenance of the trainer through routine inspections and a study of operating parts, including nomenclature, all gauges and desk controls, the telegon system, tube tester, recorder, the wind-drift mechanism, compass deflector circuit, and radio simulating equipment. Disassembly, reassembly, and lubrication of the trainer are also practiced.

Flying instruction is divided into basic and advanced, the basic taking the student through straight and level flight, turns, common errors, climbs and glides while turning, practice in rough air, slow flight, emergency pull-ups, and stalls without spins.

In their study of instruments, students pay special attention to the direction gyro, turn and bank indicator, artificial horizon, aircraft clock, suction gauge, vacuum systems, air-speed tubes, air-speed indicator, the altimeter, its correction and setting, vertical speed indicator, and magnetic compass.

Navigation Instruction

Navigation calls for a study of Mercator, Lambert conformal, gnomonic, and polar stereographic projection systems; dead reckoning; ground speed; wind triangles; drift problems; and radius of action problems.

Advanced flying covers check and procedure turns, the 90° system, standard instrument approach, cross-country problems, the parallel system, and the Army and Lorenz systems of instrument landings.

Radio aids to navigation is a separate phase in which the student learns antennas, bisectors, signals, mechanical beam bracketing, radio compass, range characteristics, outbound headings, radio telephone procedure, frequencies, radio-range transmitters, and marker beacons.

Meteorology

A general course is given in meteorology, types of weather reports, federal airways system, general traffic rules, Pibal reports, icing conditions, and thunderstorms.

Control Tower Operators Course

Control tower operation consists of the mastery of several fields of aircraft operation by one specialist in

This advertisement is one of a series which will appear in national magazines and newspapers this year as Consolidated's contribution toward a clearer public understanding of "aviation geography."

Approximate flying time shown is based on a speed of 200 m.p.h. from Kansas City, Mo.

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Try to Find a Spot that's more than 60 Hours from Your Local Airport!

No matter where you look on a globe today, you won't find a spot *anywhere* that can't be reached in 60 hours' flying time from your local airport!

Perhaps you hadn't realized that the world had become so small. Many Americans didn't . . . until it was almost too late.

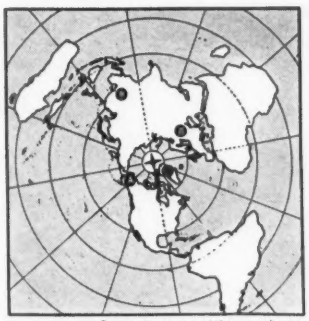
They thought of the earth in terms of vast distances and natural protective barriers. They believed that a country "isolated" by two oceans thousands of miles wide, had little to fear.

We had made the mistake of looking at maps in terms of *rowboat* geography. We learned our mistake when the Axis took our own invention, the airplane, and taught us the grim fundamentals of *aviation* geography – first over Britain, then at Crete, and finally at Pearl Harbor.

Now we know that to win this global war and build a lasting peace, we must revise our geographical thinking. We are looking at our maps more intelligently, and we are drawing *new* maps which show us global geography more clearly. These new maps have shadows on them, cast by wings. And they show us the world as it really is, because of the plane – a clustering of Air-age nations which must forever more be close friends or close enemies.

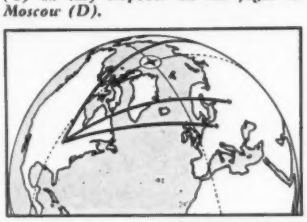
To survive as a nation and to live in peace in such a world, we must completely understand the simple and important truths which our new maps so plainly tell us. This means we must *restudy* geography.

For only then can we fully understand why supremacy in the air is a "must" for America, both for winning the war and for securing the peace that will follow.



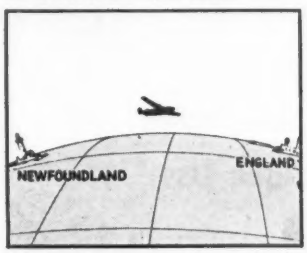
Polar azimuthal equidistant projection

On a global projection *of the earth, we see the nations in their true relationship. Alaska (A) is merely a way station on the route to Chungking (B) – and Greenland (C) an easy stopover on the flight to Moscow (D).*



Orthographic projection

No longer *can we think of Europe, Russia, or even China as remote bodies of land on "the other side" of the world.*



One day last year, *a Liberator bomber flew to London in 400 minutes. On that day, the Atlantic was no longer an ocean, but a millpond. Even this amazing record was beaten several weeks ago when another Liberator hopped across the "pond" in 372 minutes!*

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The Consolidated Vultee Liberator bomber has the greatest speed, bomb capacity, and flying range of any American 4-engine bomber now in mass production. It has a range of 4000 miles and a service ceiling of 35,000 feet.

• • •

When Anthony Eden visited the U. S. recently, he flew over from London in the "Commando" – the same Liberator bomber in which Winston Churchill flew to Moscow and, later, to Casablanca and Turkey.

• • •

FREE: Consolidated Vultee is eager to make whatever contribution it can toward a clearer understanding of today's new global geography.

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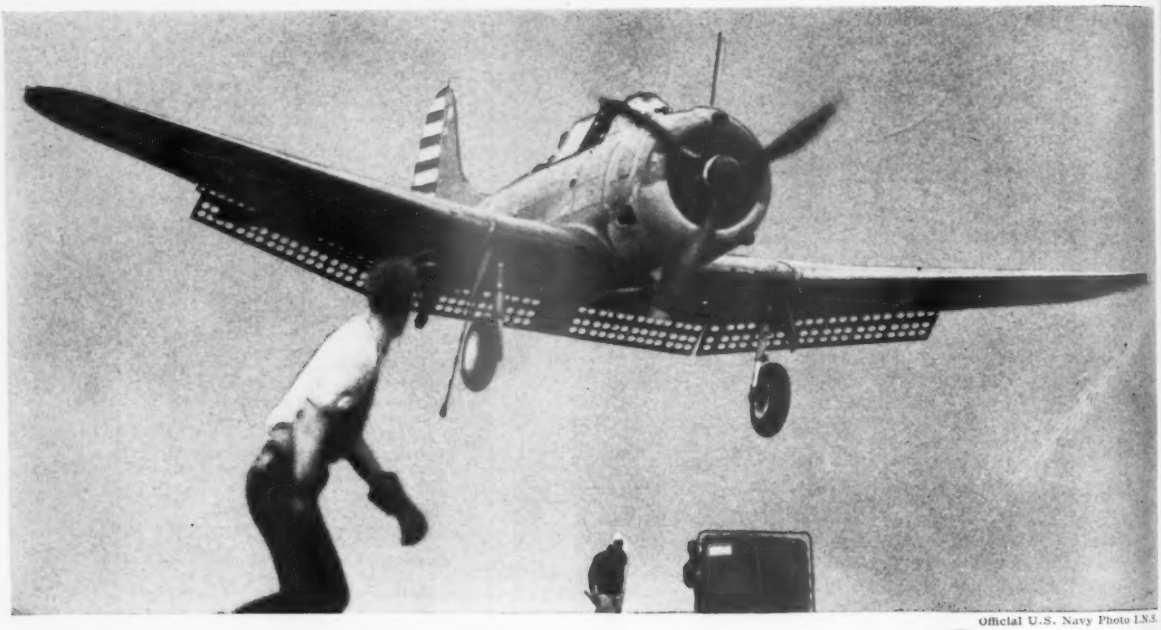

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SPEED, more speed, quick take-off, fast landings on sand, on carrier decks, on steel, on ice. Heavier loads, short runways . . . all contribute to the brake material problems of changing global combat.

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order that he may be able to coordinate and direct traffic in and out of air bases. The control tower operators course prepares men for this work.

At the outset of the course, prospective operators must learn the principles of weather to be used in guiding the landing and take-off of aircraft. This includes teletype transmission and reception, a study of visibility, gust velocities, obstructions to vision, dew point, wind-velocity equivalents, altimeter-setting systems, airway forecasts, and the phonetic alphabet.

Second, the operator must be able to identify aircraft instantly, particularly as a protection against the enemy. This is taught at present by means of models, but a new system, known as the flash system, is soon to be inaugurated. Pictures of airplanes will be flashed on a screen and the students will be expected to develop gradually an instantaneous response through a progressive shortening of the flash period.

A special course is given in enunciation and voice in order to develop voice quality, enunciation, placement, proper breathing, resonance, and phraseology.

Under radio aids to navigation the student learns the purpose of radio-range stations, cones of silence, the "Z" marker, and the fan marker.

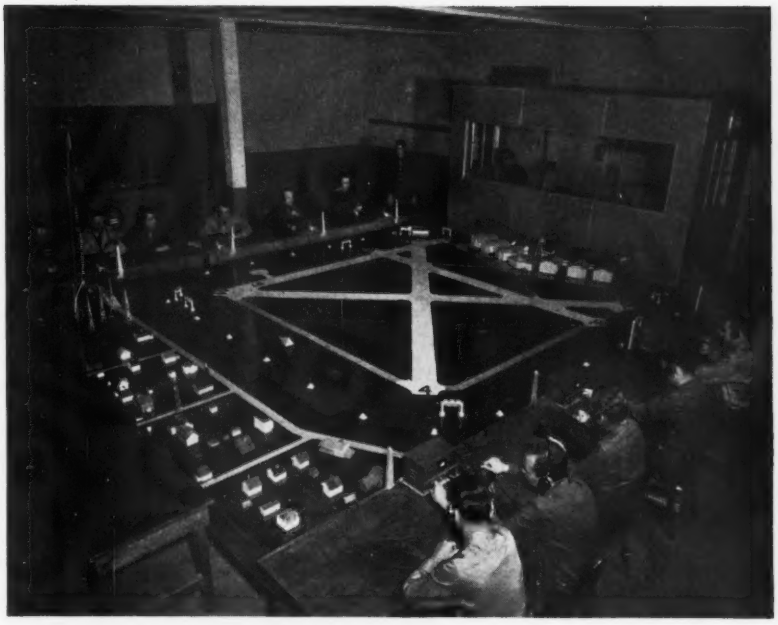
A complete phase is devoted to air traffic regulations, standard traffic control procedures, band lines communications, notices to airmen, and the airways demonstration unit.

The study of control tower equipment and procedures entails examination of such devices as the frequency meter, Friez weather indicator, station altimeter, lighting equipment, and use of logs and the flight plan. The student learns how to check periodically the settings of his receivers with the frequency meter and how to control traffic with a signal light (biscuit gun).

The Link Trainer

In radio orientation and instrument flying trainer, the student is taught methods used by pilots to locate a radio beam and follow it to the station and also the procedure of instrument letdowns, landings, and drift correction. The Link trainer is used at this point in order to teach instrument flying procedure to the control tower operator so that he knows the pilot's problems. He studies straight and level flight, turns, climbs, glides, emergency pull-ups, making turns to gyro headings, mechanical beam bracketing, procedure turn arounds, flying the true fadeout system, and the low approach system.

On a mock-up of an airfield, illustrated in Fig. 8, the student is given the opportunity to apply what he has learned and is given practice in flying procedure as well as in control tower operation. He issues and receives traffic control instructions. On the first day of the phase the students observe the control tower at Chanute Field in order to study their work at close range.



Photograph by the Army Air Forces Training Command

FIG. 8. Practice in actual airfield control tower work is provided by this mock landing field, complete with all field buildings and the control tower. The students act as aircraft radiomen, studying control tower signals.

Upon graduation, the students are assigned to various fields. They must pass rigid physical examinations, especially as to eyesight, hearing, and temperament. The operator must have presence of mind and the ability to give answers rapidly and accurately in case of emergencies. Graduates are qualified to take the Civil Aeronautics Authority control tower operator's examination.

TELETYPE MAINTENANCE COURSE

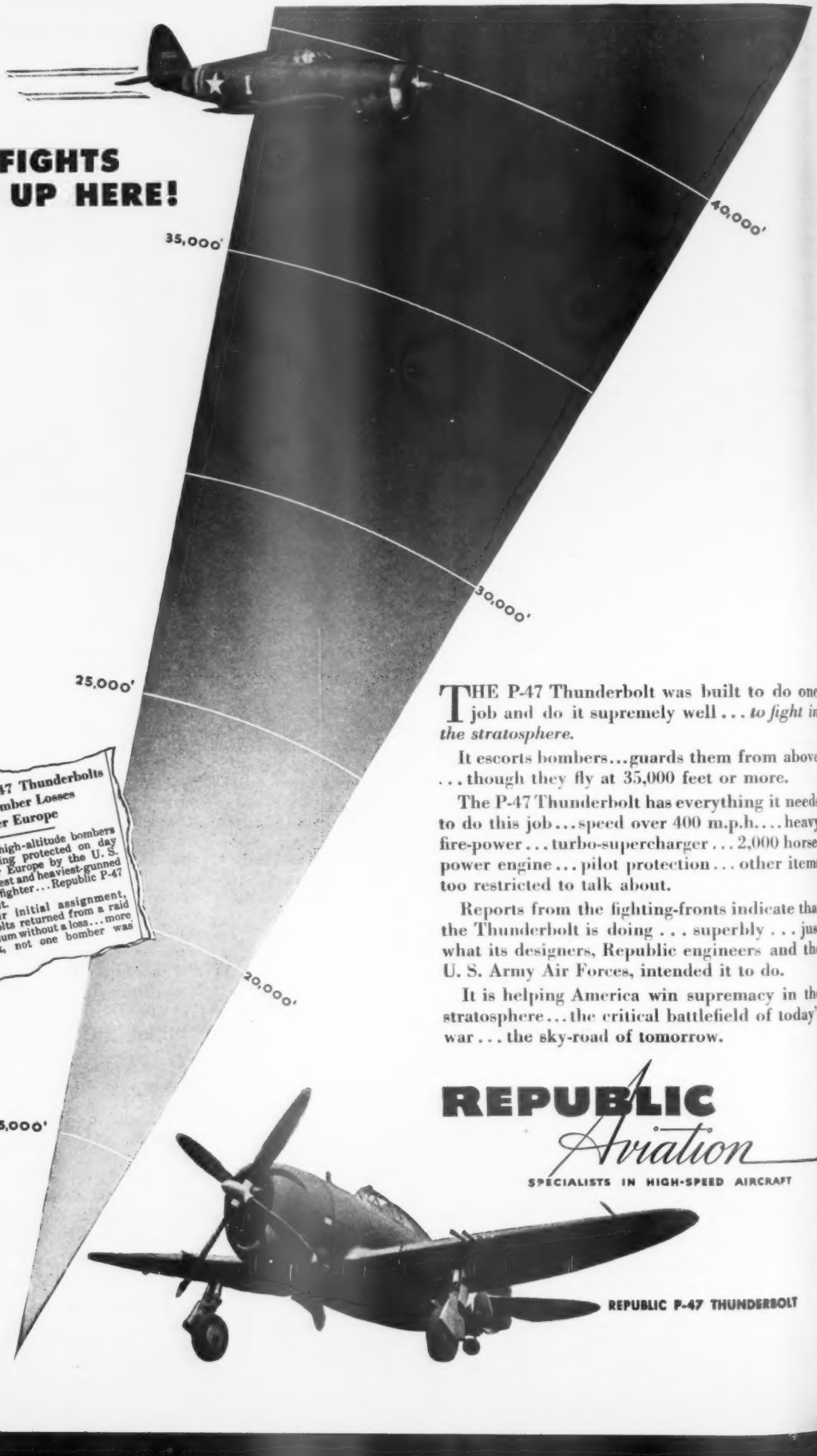
The Army Air Forces have a need for a speedy means of communicating official messages and weather information. Weather data are of vital importance to the safe operation of all aircraft and are usually supplied through a vast complicated network of teletype lines that link weather stations with all flying fields.

There are several advantages in the use of teletype as a means of communication: It is more rapid, reliable, and exact than any other method of electrical transmission of messages; it can work at high speed over poor lines; there is usually no delay for encoding and decoding of messages, as interception by the enemy is easily detected; it is unaffected by static as is radio communication; telephone lines can easily be converted into teletype lines.

To set up and maintain all of the necessary equipment requires a large force of trained teletype technicians; such technicians are trained in the teletype maintenance course.

All training in this course points toward familiarization with the adjustment, maintenance, and repair of teletype machines and accessory equipment. During the first phase of instruction students become familiar with the standard teletype M-15 printer sets and the fundamental principles of electricity. In their study of electricity the students learn the purpose and meaning of electrical symbols and abbreviations, the meaning and application of electrical potential, current and pressure, types of circuits, Ohm's law, Kirchhoff's law, basic magnetic, formulas and phenomena, capacitance and its application to teletype equipment.

As the student continues in the course he progresses from the simple to the more complex mechanisms. Since graduates of this course are charged with the responsibility of maintaining teletype apparatus (Fig. 9), a great deal of their study involves the analysis of mechanical and electrical troubles. It is essential that he be thoroughly familiar with the construction and principle of operation of all the equipment. Analysis of teletype wiring diagrams pertaining to the M-15 set; fundamental magnetic and electrical reasons for operation of the Western Electric Polarized Relays, models 215-A, 215-H, and 255-A; theory of operation to


IT FIGHTS
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40,000'
35,000'
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20,000'
15,000'
Republic P-47 Thunderbolts
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American high-altitude bombers are now being protected on day sweeps over Europe by the U. S. Army's fastest and heaviest-gunned single seat fighter... Republic P-47 Thunderbolt.
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Reports from the fighting-fronts indicate that the Thunderbolt is doing... superbly... just what its designers, Republic engineers and the U. S. Army Air Forces, intended it to do.
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Photograph by the Army Air Forces Training Command

FIG. 9. An inspection of a small internal part of a teletype machine is shown to the student. At the left is the transmitter distributor, a device for sending automatically, by means of perforated tape, a message to a teletype receiver at the other end of the line.

cover printing overlap, selecting period; distortion and orientation are taught along with the trouble shooting. Later the student gets instruction in the elementary connections of the model M-15 on neutral signal line in preparation for trouble analysis.

In an introduction to accessory equipment as used on the model 19 composite set, special emphasis is placed on the PEX-14 and PEX-20 keyboards in conjunction with the presentation and analysis of polar operation. The student gets practice in the adjustment and correction of troubles in the PEX keyboard.

In the final phase of study the students are instructed in the operation and maintenance of all elementary and advanced communication systems, including push-key cabinets, jackboxes, safety devices, station wiring, and monitor stations.

CELESTIAL NAVIGATION TRAINER COURSES

The title "Celestial Navigation Trainer" is somewhat of a misnomer because the trainer is designed and used for training an aerial combat crew in coordination between the pilot, navigator, bombardier, and radioman as well as in celestial navigation itself. The stage at which the C.N.T. is most adaptable and useful is when each member of the crew has just finished his individual training at an Air Forces school and is combined with others into a newly formed crew. It is essential that all members of the crew work together as a single unit, and the C.N.T. brings the individuals together to coordinate their work.

The Celestial Navigation Trainer is a synthetic device consisting of a fuselage complete with controls, instruments, and equipment for the navigator. This fuselage is so mounted that all aircraft movements may be simulated. Mounted under the fuselage and visible through a window in the floor is a screen on which is projected, from underneath, an image of terrain from a mosaic photograph that has been printed upon a glass plate. The glass plate represents an area of about 50 by 100 miles and is constructed to exact scale. As seen from the fuselage the size of objects is as though they were viewed from a 10,000-ft. altitude. The image on the screen moves in proper relation to the heading of the fuselage, the air speed, and the wind direction and velocity.

Above the fuselage is a "celestial dome" on which are placed stars in proper relation to each other and according to their declination and right ascension (sidereal hour angle). The dome is movable according to passage of time and according to change of observer's (navigator's) position—i.e., latitude and longitude.

In carrying out a given mission the crew is briefed and given meteorologic data and other information in the same manner as is done in an operating unit. Each member prepares for the mission by necessary preflight calculation, consultation with each other, etc.; then the crew members take their positions in time for the appointed time of takeoff. The crew flies the trainer through the mission, every movement being recorded by an inked trace on a chart. This inked trace is an indisputable record of how well the navigation, steering, and bombing were performed. Every type of mission or exercise can be performed—pilotage, dead reckoning, radio direction finding, and also every type or method of celestial navigation, including flights at extremely high altitudes or over the poles.

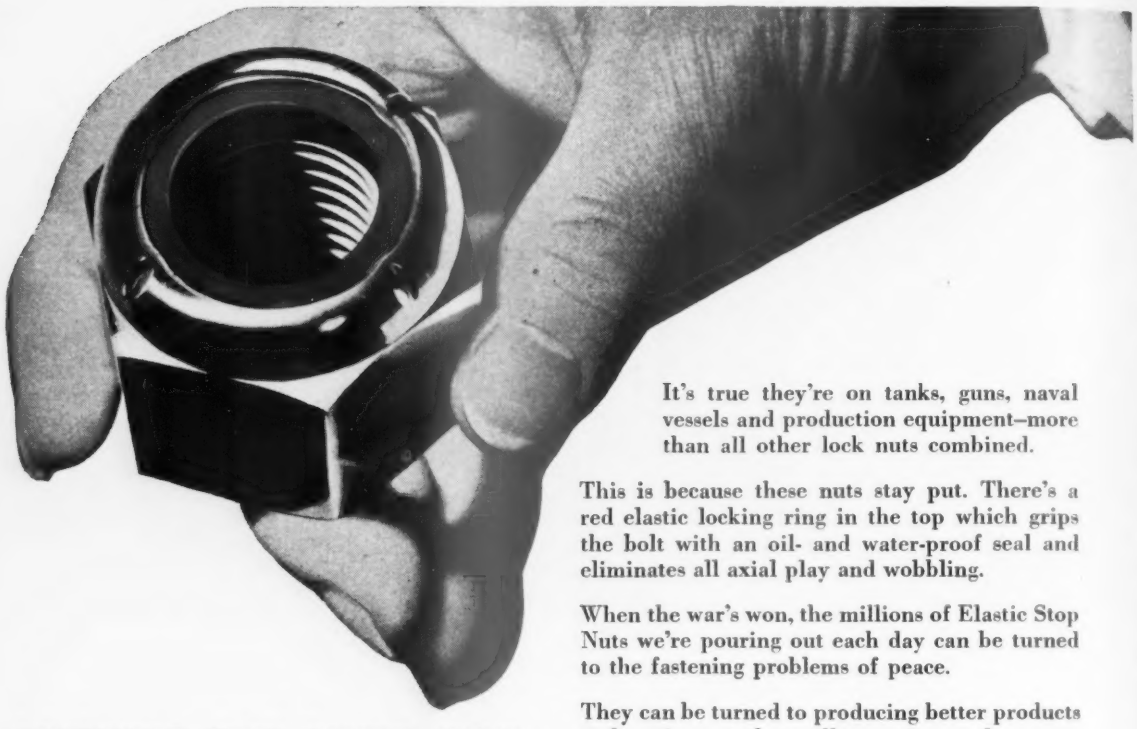
There are three C.N.T. courses: the C.N.T. operators, who are taught to set up and operate the controls of the trainer during any type of problem or mission; the C.N.T. maintenance men, who are taught to adjust and maintain all parts of the trainer so that it will operate correctly; and the C.N.T. instructors, who are taught to employ the trainer for crew coordination instruction. The last-named course is given only to specially selected graduate commissioned navigators holding that aerial rating.

WEATHER OBSERVERS COURSE

The weather forecasts, upon which the life of an A.A.F. pilot depend, are derived from the accurate observations of the weather observer, thus making it imperative that well-trained men be placed in this field for the proper maintenance of aircraft.

The weather observers course includes the following skills: (1) making the observation; (2) encoding the report and transmitting it over teletype circuits; (3) preparing charts from collected reports; and (4) giving weather information to pilots. In order to be accepted for this course, men must have had a scientific background with work in mathematics.

Students are required to make observations every day during this training period so as to acquire a well-rounded experience in all types of weather conditions. The observer at a regular A.A.F. station makes surface (lower atmosphere) observations every hour. These include such elements as type, height, and direction of clouds; visibility and obstructions to visibility; kind and amount of precipitation; wind direction and velocity; temperature, pressure, dew point, relative humidity, altimeter setting, etc. Upper air observations, using the theodolite (surveying instrument, Fig. 10, with a right-angle prism) and a hydrogen balloon, are also made by students in this course. No attempt is made to provide study of the radiosonde (a transmitter that sends radio reports of temperature, pressure and humidity while aloft), but the students plot and



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It's true that Elastic Stop Nuts are flying in every American plane – sometimes 50,000 of them in a single ship.

It's true they're on tanks, guns, naval vessels and production equipment–more than all other lock nuts combined.

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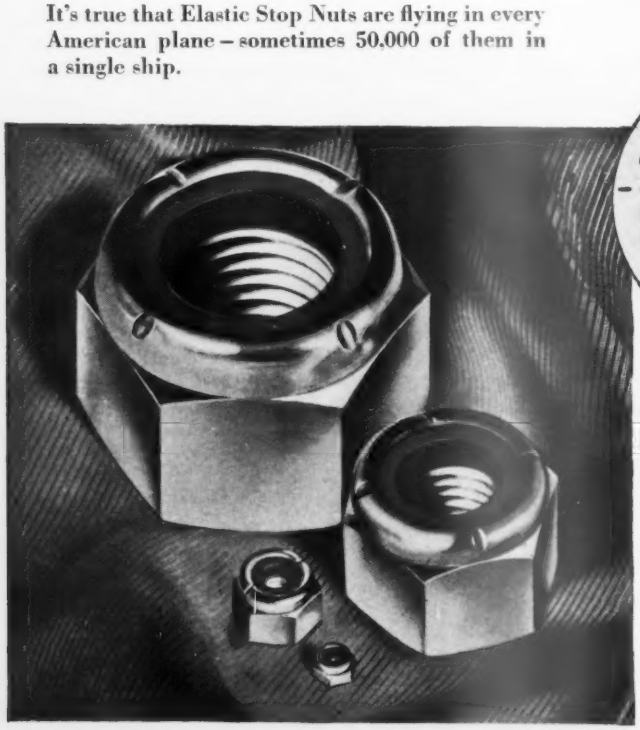
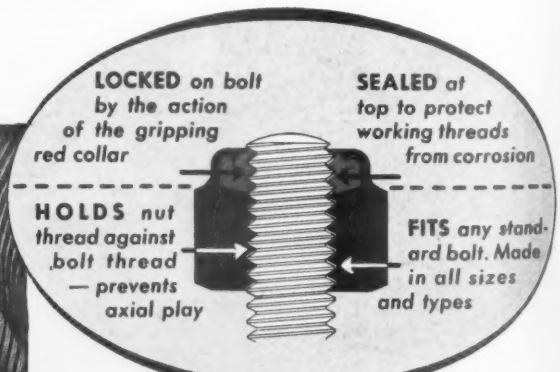
When the war's won, the millions of Elastic Stop Nuts we're pouring out each day can be turned to the fastening problems of peace.

They can be turned to producing better products and equipment that will save time and expense for maintenance engineers.

Whatever your fastening problems might be, our engineers, experienced in the work of both war and peace, will be glad to help cope with them.

Feel free to call upon them. They'll work with you and suggest the proper Elastic Stop Nut to lick the job.

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encode radiosonde observations on atmospheric sounding charts.

Meterology, the study of the "why" and "how" behind weather itself, is taught in conjunction with the various phases of the weather observers course, thus enabling the student to understand the interrelationship of various phenomena. Graduates of the weather observers school are sent to A.A.F. weather squadrons throughout the world. Those who prove qualified may be later returned to take forecasting training at other schools.

The instruments used by the weather observer are varied. They include, in addition to those already mentioned, the thermograph for recording temperature; the hygrograph for recording humidity; the psychrometer for measuring humidity at a certain time; the barometer for indicating pressure; the barograph for recording pressure; the rain and snow gauges and recording devices; the anemometers for measuring air speed; the vanes for recording and indicating wind direction; the quadruple register for recording rainfall, wind direction, wind speed and duration of sunshine (although the latter is not used); the double register for recording wind direction and speed; and the operation of the teletype machine on which the student must encode, send, and decode weather messages. This coding is done not for the purpose of secrecy but speed. The making of observations on weather instruments is taught not only as a science but also as an art in the use of judgment.

In the use of the theodolite, students must take elevation angle readings and readings of angles made with true north in order to obtain information concerning wind direction and velocity. By mathematical conputation, the path of the balloon is plotted on a plotting board giving a graphic representation of the journey of the balloon. Again, by trigonometric functions, the direction and velocities of the winds aloft at standard levels are determined. This information is valuable to the pilot so that he may know at what levels to fly for the best operating efficiency.

After observations are made, they must be encoded. So efficient is the teletype system that within one hour it is possible to get the complete weather information from more than 1,000 weather stations in the United States. As the collected data come over teletype machines, the observer decodes them and plots them on a map. Each report contains about 20 different items concerning conditions at a particular station. Twenty seconds are required to send the weather report from a single station, and 20 sec. are required to plot the information at the receiving station. The observer must know how to plot ten different kinds of charts, some of them drawn up four times a day. All this must be taught in 10 weeks.

Photograph by the Army Air Forces Training Command

FIG. 10. A student prepares to follow a hydrogen-filled balloon into higher atmosphere levels with a theodolite in order to check wind direction and speed.

The weather instrument phase of the course is designed on the assumption that every observer may have to build a station and will have to keep that station in operating condition. At the end of the course, time is spent simulating station experience.

SPECIAL PURPOSE MOTOR VEHICLE COURSE

Many types of motor vehicles have been designed to do the work required to service the airplane. These vehicles are built for a specific purpose such as hauling gasoline, towing airplanes, picking up wrecked airplanes, handling air freight, removing airplanes wrecked in water, and many other similar jobs. For this reason they have been grouped together under the heading of "Special Purpose Motor Vehicles."

Specialists have to be trained to operate and maintain these vehicles since each one is quite different from an ordinary automobile, tractor or truck. One of the prerequisites for entrance to the course is the ability to drive an automobile. Graduates are assigned to various service units as drivers and operators of any of the vehicles used; it may be a 40-ft. gasoline truck, a crash truck, a tractor, or any other similar vehicle. They must perform periodic inspections as well as first and second echelon maintenance of the vehicle they operate.

The special purpose motor vehicle course begins with a study of the construction and operation of various types of engines including the Diesel engine. A special study is made of the electrical system (including the electrical units, wiring, and battery) and carburetion, cooling, and lubrication systems.

Students then receive instruction on the vehicle as a whole. They must become familiar with the constructional features, operative principles, and inspection and maintenance of the vehicle and its equipment. Such equipment as brakes (hydraulic, electric, and air), clutches, chassis units, steering units, etc., are given special consideration.

Accessory equipment to special purpose motor vehicles, such as air compressors, portable ground heaters, portable field lighting equipment, etc., are a vital part of this course. The student must learn to operate and service this equipment under all possible conditions of weather.

Because it is not always possible to have the proper equipment at the place where it is needed, especially in combat areas, the students are instructed in the use of "pioneer equipment." This equipment includes block and tackle, winches, and "A" frames and anchorages that are used to improvise means of moving vehicles out of traps, loading airplanes, righting overturned vehicles, and numerous other similar jobs.

Finally, the student learns to drive the vehicles on single expeditions and in convoy. He must be familiar with traffic and driving rules, driving on

(Continued on page 67)

Training planes "stood up" for these Christenings

Back of the boys with the wings are the training planes that nursed them along through some trying times.

The great trainers that have helped build our air force don't get into the headlines, but they have a favored spot in the hearts of America's pilots. When the experienced flyers look back, they salute the PT's and BT's and AT's for the beatings they were able to take.

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Lofting—The Keynote to Aircraft Production

LEE H. WILLARDSON*

Bell Aircraft Corporation

To have looked into the Bell Aircraft Corporation factory a little more than two and a half years ago would have revealed what rightfully could have been called a small experimental airplane laboratory. A small group of aircraftsmen could have been seen just putting the finishing touches to the last of a group of 13 airplanes, a contract that had taken over two years to fulfill.

Even though a vast amount of time and money had been spent in building tools, jigs, and fixtures, parts had to be hand-tailored for every ship. Interchangeability of parts was just something people talked about. The saying of "bump to suit, file to fit" was the rule of the day.

Today the picture is changed. In the short span of two and a half years Bell Aircraft Corporation has emerged from the cocoon of a small experimental airplane laboratory into a full-fledged major aircraft factory. Today this same small group of aircraftsmen, now supervisors and leadmen, direct the activities of thousands of relatively inexperienced men and women, launching into the air each single day more airplanes than they had been able to build in two years previously.

How was this transformation brought about? The answer is quite simple. The management of Bell Aircraft Corporation realized that with the gathering war clouds they would soon be called upon to build aircraft in numbers hitherto undreamed of. They realized, too, that, because of conditions arising in the field and because they had always built peacetime airplanes, numerous changes would have to be made. Of course, these changes would have to be made without slowing down production. To do this meant that detail parts would have to be made one like the other, that is, interchangeable. The tooling would have to be simple and readily changeable, to say nothing of having to utilize relatively inexperienced men and women for the assembly work.

For the solution of this problem they turned their attention to a system devised by the shipbuilding industry years and years ago. They borrowed the technique of the age-old shipyard mold loft. It is true that lofting had been practiced in the aircraft industry prior to this time, but to a small degree. Lines work only was done, and little thought was given to template work and, particularly, coordination of parts.

So sure was the management of Bell Aircraft that this was the answer to their problem that without hesitation they scrapped 30 per cent of their original design on the Bell Airacobra so that this system could be used efficiently. They were not wrong. Using 100 per cent lofting on the production of Army P-39 Airacobras has proved to be a huge success.

History of the Loft

As mentioned above, lofting was borrowed from the shipbuilding industry. In the shipyards, to delineate the form of a vessel and to insure that the lines were fair required that the body lines be drawn at full scale and faired on a plane surface where a visual examination of the lines could be made. To do this work on a large vessel required a vast amount of clear floor space. To avoid using valuable ground floor area, a floor was built over and above the machinery and fabrication areas. This was known as the "loft." The templates that were made from the lines for shaping the frames and shell plating were called "mold templates"; hence, we have the name "mold loft."

Shipyard lofting is a craft that was developed to answer an urgent need which, besides establishing the external contours of the vessel, was laying out, in flat pattern, templates for the structural members and shell plating of the ship, all of which have curvature. Also, it laid out all of the holes in all of the parts so that the holes could be used to assembly the ship.

The frames and shell plating of ships were made of heavy gauge steel, ranging from $1/4$ to $1\,1/2$ in. or more in thickness. Obviously, with steel of these gauges, drilling on the assembly was out of the question. By having the rivet holes prelocated accurately in all the parts, it is easy to see how the parts were made to assemble themselves. The holes in the bulkheads served to locate the shell plating and the shell plating served to locate the bulkheads. With accurately located holes, location of parts was positive, and mislocation of parts was almost impossible. This is known as "coordination." Here, with the coordination of parts, is where lofting has proved its value in the aircraft industry.

Development of Aircraft Lofting

Until the metal-covered, streamlined airplane made its debut in the aircraft industry, lofting did not exist. All the layout and descriptive geometry work necessary was done by the engineering department. The external contours of the aircraft were made up of simple geometric shapes or were left to the discretion of an esthetically minded shop that took extreme pride in handiwork. Production and interchangeability were not seriously considered. The men who did the actual assembly work had to be first-class craftsmen.

In about 1927 metal-covered floats were designed and built for a Navy seaplane. These were followed by the metal-covered hulls of flying boats. On these projects a first step toward lofting was made by laying down rough lines to full scale. Not much care was taken to insure that the lines were fair. Most of the contours were made up of straight lines and circles. Wooden form blocks or mock-ups were made for the more complicated shapes.

It was, perhaps, a fortunate circumstance that these first attempts were on floats and hulls, because they suggested the borrowing of the methods of the age-old shipyard loft. The first true aircraft loft with ship lofting methods was started in 1928 on the hull of a Navy patrol boat. Success of the experiment was vital because, in the quantity construction of all metal aircraft, parts had to fit together at the first attempt and could not be sawed and planed to fit.

Advantages of the Loft

It was not until the aircraft industry became streamline conscious and began the use of fillets, fairings, sleek streamlined fuselages, tapered metal wings,

* Chief Loftsman.

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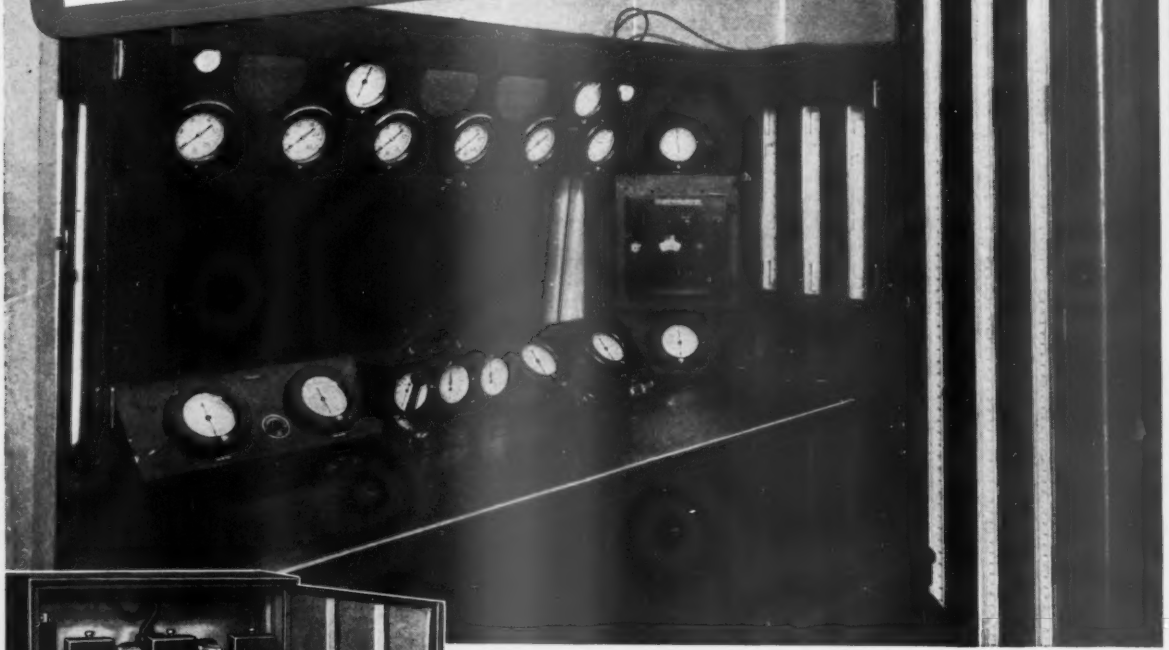

★ This view, of cabinet with front door open, shows how manometers and fluorescent lights are arranged for good lighting and quick accessibility. Installation is for a prominent aircraft engine manufacturer.

THIS control equipment, for a production stand testing aircraft engines, is a highly efficient unit.

All manometers required are housed in cabinets with fluorescent lighting, providing utmost comfort and visibility in reading.

Meriam manometers measure manifold pressure, airflow, carburetor pressure drop, venturi pressure, air stack pressure, crank case pressure and other pressures, vacuums and differentials as required.

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and the like that the full advantages of the loft were realized. The loft proved to be an agent capable of producing complex, fair, geometric surfaces in space in such a manner that flat pattern templates could be readily made for fabrication of parts and tools in the shop. At Bell Aircraft every surface of the airplane is faired in the loft, and coordinated flat pattern templates are made for every sheet metal part.

The one big factor that contributes to the success of lofting at Bell Aircraft is the fact that all the basic lines and template work on the airplane are handled by a small specialized group of men, thus giving complete and accurate control over the whole airplane relative to shape and interchangeability of detail sheet metal parts.

The organization of the loft at Bell Aircraft is grouped into two main divisions—namely, the lines group, which does the actual lofting and laying down of lines; and the template layout group, which works from the lines furnished by the lines group and the engineering detail prints to produce flat pattern templates of parts to be formed by the shop.

The Lines Group

The fairing of an airplane is done on an especially constructed wooden floor, the surface of which is covered with battleship linoleum. Lines are laid down at full scale. Curved contours are drawn with the aid of wooden splines or battens, which are weighted down with lead ducks or nailed to the floor (Fig. 1). Battens as large as the curvature will permit are used to insure that the lines will be as free as possible from unwanted dips and hollows. Battens range from $^1/_{16}$ by $^1/_4$ in. to 1 by 2 in. and are often spliced to attain the desired lengths on long fuselages. Body plans are laid down on three-ply birch boards.

Points or dimensions are transferred from view to view with the aid of a "sheer pole." Use of scales, with the attending possibility of errors, is avoided. Sheer poles are usually made of spruce sticks which are $^1/_2$ by $^1/_2$ in cross section, the length being governed by the work being done. Points are transferred from the layouts to the sheer pole by means of "pickup." (Fig. 2a).

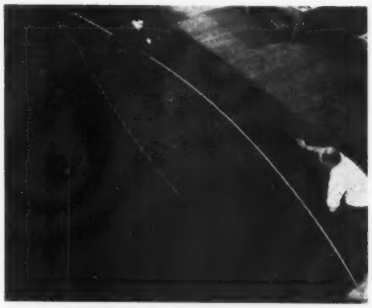


Fig. 1. Using the small sketch and general dimensions provided by engineering, lofting engineers draw a full-sized outline of plane. Curved lines are drawn with flexible strips of wood to insure smooth contours free from unwanted dips and hollows. This serves as the final, basic, reference drawing. It is the "standard" from which all future dimensions are derived.

The loftsman's common tools differ somewhat from those of the draftsman —steel straightedges, steel scales, scribes, and the like being used. An engineer's transit is used for laying down long straight lines such as the basic reference lines on the floor.

Laying Down Lines

In following through the actual process of laying down lines, the fuselage will be considered first. For this the loftsman must have, from engineering, a scale drawing on which the following information must be shown:

(A)—Profile view (the outline of the plane of symmetry and the frame stationing).

(B)—Plan view (the outline of the fuselage through the reference line or the approximate horizontal center line of ship).

(C)—Body plan (which gives the shape of the fuselage on transverse vertical planes—i.e., on the fuselage stations planes at sections that have to be particularly held).

(D)—Cockpit enclosures (approximate definition of glass planes, etc.).

(E)—Doors, floors, and any other items affecting frame spacing or shapes to be held within certain limits.

The Profile View

After receiving this preliminary information, the loftsman locates the station positions of all of the frames on the loft floor and also plots the points for the profile as scaled from the engineering drawing. This profile is then faired smoothly from point to point, holding those particular heights so dimensioned on the special sections shown on the drawing. In conjunction with these lines on the floor, a set of body lines or sections is also laid down by scaling, as closely as possible, those shown on the drawing. With this much completed, the loftsman is ready to lay in the remaining station contours on the body plan. From the profile on the floor all of the heights along the centerline of the airplane are obtained. These points are picked up on a sheer pole and transferred to the body plan, all at one time.

The Plan View

The plan view is faired in the same manner as was the profile view. From this view the half breadths of the frames are obtained. These points are picked up on a sheer pole and transferred to the body plan. Through these points, so located for each station, and following the general appearance and feeling of the previously drawn sections, the contours are drawn in pencil with the aid of a wooden spline and ducks (Fig. 2b). These contours are rough and have yet to be faired.

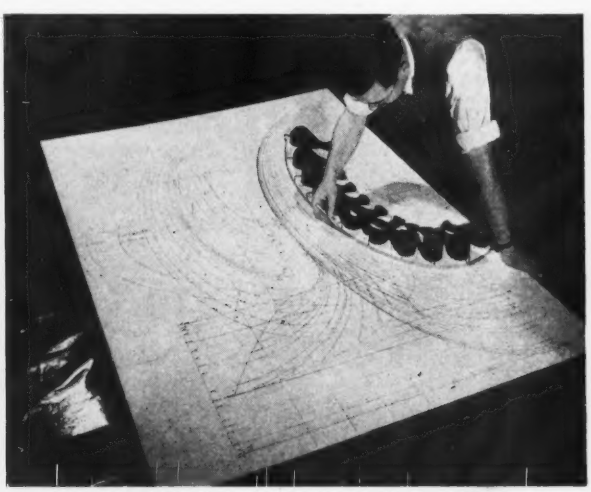
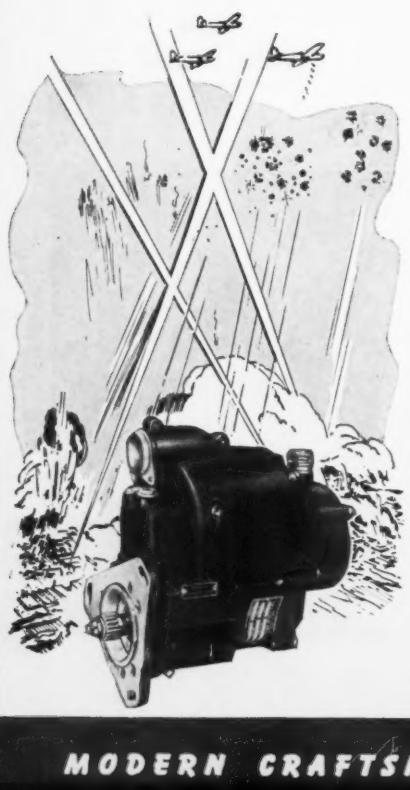


Fig. 2a. Bell Aircraft methods call for transfer of points from the loft floor to the body plans on sheer poles. Dimensions are never scaled. Fig. 2b. On the body plan, contours are drawn in pencil with aid of a wooden spline and ducks.

The Last Thousand Feet



OUR heavy bombers and the enemy's ack-ack guns are pitted in an endless race for altitude. The last thousand feet make all the difference and present the supreme test of pilot, plane, and equipment. American Bosch magnetos were designed for that last thousand feet ... built to perform unfailingly far higher than ever before required.

The dependable magnetos flowing from American Bosch assembly lines are the product of *modern* New England craftsmanship. American planes outfly the flak with the help of magnetos made by our *specialist* craftsmen — men and women, 20 to 60 years of age, trained for specific jobs.

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AMERICAN BOSCH CORPORATION • SPRINGFIELD, MASSACHUSETTS

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AVIATION AND AUTOMOTIVE ELECTRICAL PRODUCTS . . . FUEL INJECTION EQUIPMENT

MODERN CRAFTSMEN IN THE NEW ENGLAND TRADITION

Fairing

Fairing in some respects is a trial-and-error process and is accomplished by taking cuts through the fuselage sections, plotting the points on the floor, and examining the resulting contour. The points from the first attempt will not usually fall on a fair curve, but the loftsman decides on a mean fair curve that suits his eye. The revised points are transferred back to the body plan and the contours are altered accordingly. Other trial cuts are taken and the process is repeated. After this has been done several times, the body plan contours may begin to show dips and hollows or will not be shaping to the loftsman's liking, in which case alterations are made. And so it goes, back and forth, until every cut will give a fair curve without further alterations.

In shipyard practice the cuts are usually made through vertical and horizontal planes—i.e., along buttock and water lines—but in aircraft work the loftsman does not limit himself to these. He uses many diagonal cuts, usually approximately normal to the surface being faired. The final result will have been faired by cuts, every 3 in. or so around the contour.

Body Lines

The next and final step, after having faired all of the frames in the fuselage body plan, is the location of longitudinals, floor lines, and the like. These items are definitely located by the designing engineer.

When the body lines have been faired to the loftsman's satisfaction and are given the final approval of the designing engineers, they are scrived or cut into the board with a scrive knife, and designating numbers are stamped into the board for the various longitudinals and stations. The grooves made by the scrive knife are filled in with colored pencil, and the board is coated with clear lacquer to preserve the surface and to keep the lines clean.

Detail Layouts

At this point the lines information on the fuselage is furnished to engineering for their detail layouts (Fig. 3). This is done by placing a piece of tracing paper over the body plan and tracing the lines by directing a pencil around the scrived grooves. This has a decided advantage over furnishing ordinates, inasmuch as it eliminates the time that would be required to plot the curves and respline them. Possibilities of errors in plotting ordinates and location of structural members are also greatly lessened.

In passing, it might be said that there has been a definite trend among some of the aircraft companies toward mathematical solution of lines or contours for such things as fillets, fuselages, and so on. This can be done, but, inasmuch as the work on the lines comprises such a small percentage of the man-hours involved in lofting an airplane, the advantages or disadvantages of these different processes of fairing are really immaterial.

Fig. 3. By placing a piece of tracing paper over the fuselage body plan in the lofting department, the lines are traced off for making structural analysis and detail drawings in the engineering department.

When the fuselage lines are complete, only the body plan is preserved, since it contains a complete picture of the lines and since it carries sufficient information to make both the detail drawings in the engineering department and the flat pattern templates for the production of parts in the shop and the information required to erect holding fixtures with which to assemble the finished airplane.

The Wing Plan

The next board to be laid out in the process of lofting an airplane is the wing board. At present, the straight taper wing is used almost exclusively; for this type, the body plan alone is sufficient for most of the layout.

The Wing Board

On the wing board are shown (Fig. 4): the true contour of each rib in the wing, the traces of the spars on each rib, flap and flap cutouts, aileron and aileron cutouts, the chord line, and the reference lines. The wing body plan is laid out so that the planes of the ribs are normal to the chord plane and the traces of the ribs on the chord plane are parallel to the plane of symmetry of the airplane. This arrangement simplifies the layout, inasmuch as the chord plane is seen as one line and is common to all of the ribs in the wing.

In order to start the wing board the loftsman must first have a drawing showing the chord lengths at the root and tip airfoils, the semispan of the wing, the rib stationing, and the angles of incidence, dihedral, and sweepback. Accompanying this drawing must be the airfoil coordinates for the series from which the wing was designed. These are usually given in percentages of the chord and are figured on intervals of 1.25, 2.5, 5, 10, 20 per cent, etc., according to the degree of curvature of the airfoil.

Fig. 4. On the wing body plan, rib contours, spar traces, and the like are laid out, giving a composite view of the whole P-39 Airacobra wing.

The loftsman first lays down the contours of the root and tip airfoils in the proper relation to one another. This relation is determined by the angle of sweepback and the true distance between the two ribs. The surface of the wing is then generated by connecting the common percentage points on the root and tip airfoils with straight lines. Intermediate ribs are laid in by dividing these generating lines proportionately to the distance between ribs. The points thus obtained for each rib are connected with a fair line to form the contour of the airfoil.

The lines of the wing, like those of the fuselage, are first drawn in pencil. Spar traces, aileron and flap slots, stringers, and the like are added. The path of the main landing gear as it enters the wing is plotted to determine whether clearances are sufficient and to provide basic lines for the wheel-well cutout. It is here that analytic and descriptive geometry play an important role. Location of the landing gear axis and intersection of the strut and wheel with the wing structure are done mathematically. When all of this work is done and has the final approval of the engineers, the lines are scrived in and the surface of the board is prepared in the same manner as was the fuselage board.

The Tail Surfaces

Like the wing, the tail surfaces are usually made of ruled surfaces—i.e., straight tapered. The body plans for the vertical and horizontal stabilizers are established in the same manner as was the wing body plan. However, if the surfaces are not straight tapered, then the lines on the body plans are cross-faired much the same as were the body lines on the fuselage.

Component Assemblies

As other assemblies dealing with the contour of the ship are developed during the process of the design, various other small layouts are made following much the same procedure as used for the fuselage. Examples of smaller boards are the ducts, doors, wheel cutouts, etc. In fact, whenever the detailer or layout man in engineering requires exact knowledge as to clearances with the contour or angles caused by surface fairing, the information can be obtained by reference to the loft lines. Many times during the detailing of an airplane, if only to make the drawing to scale, it is necessary to have the lines of certain portions of the ship. These can easily be obtained from the lines board by laying a piece of tracing paper over the lines in question, setting the pencil in the scrived groove, and directing the

pencil along this groove. In fact, the loft boards are used extensively to make drawings, templates, jigs, and even to check fabricated parts.

The draftsman only uses the vellum tracing to achieve an accurate drawing or layout, since no dimensions relative to the external contour of the airplane are ever given on the detail or assembly drawings.

The Template Group

So far, only the work of the lines group in the loft has been considered. As has been pointed out, this group is intimately associated with engineering but has little to do with the shop. However, there is an equally important division of the loft where the reverse is true—namely, the template group. Here it is that engineering and loft data are, to a large extent, made directly available to the shop workman. The importance of this work is apparent when it is realized that about 90 per cent of the parts fabricated in the shop are made from templates, and in the majority of these cases the template serves as a self-sufficient set of instructions for fabrication and inspection of parts, requiring no references to blueprints, thus enabling relatively unskilled men and women to perform fabrication and assembly work.

The template division has several branches. These are broken down into the fuselage, wing, empennage, and inspection. These groups are made up of men of varying skills. In the fuselage, wing, and empennage groups some men do considerable work with analytical geometry, supplying spar bevels, compound angles of attach fittings, and many other similar problems, while others do the great bulk of the template work from the lines board and engineering detail prints. The work of the inspection group differs from usual shop practice in that it is carried on by a group of loft personnel rather than by members of the shop inspection department, the reason being that the type of work performed is such as to require a vast amount of lofting experience lacking in the regular inspection department.

The templates are made on No. 16 and No. 18 gauge galvannealed sheets. The master template is laid out first. This template is kept in the loft for reference, never being allowed to be used for production work. Duplicates are made from the master template. These are painted black and are used by the shop for production work.

Template Layout

Template layout is done with scribe, dividers, scales, and straight edges. Such work is surprisingly accurate, tolerances usually being held to one-half the width of a finely scribed line. Descriptive geometry is developed to a fine art. Bisectors, perpendiculars, and the like are all laid out geometrically. There is a wide variety of types of templates made. The most common of these is the contour template, which is used to set up and check dies, fixtures, etc. Others include: the develop template, which is a flat pattern of the part with developed flanges, coordinating holes, etc.; the apply template, which is made to fit over a part that has been previously formed or extruded and is used to trim and/or drill it; the form block template, which is used to make the form block for the hydropress or crank press dies; and the router block template, which is used on the pantograph routing machine to route out parts.

The production engineering department issues travelers (work orders) and operation sheets for the templates required for the various details. In a large percentage of the cases the loft can anticipate the shop's requirements and is able to start the template upon receipt of the engineering prints. Nevertheless, a close tie-in with production engineering is necessary at all times to insure that the planning and template work agree.

Usually templates are made in sets that make up a subassembly and which are matched one against the other, thus serving to prove the correctness of the templates and the engineering drawings from which the templates were made. The loftsmen working at full scale on metal, with semiprecision tools, are often able to pick up such errors in the drawings which might go unnoticed by the engineering department. Engineering has learned to depend a great deal on the loft for double checking their drawings.

Parts Coordination

One of the most outstanding and important phases of lofting is the coordination of parts. All rivet holes are located in the flat pattern templates and are drilled or pierced into the blank parts. These holes are used to assemble the parts in the shop. Assembly work can be done on the bench by coordinating holes much the same as parts are assembled on a child's "Mechano" set, thus eliminating a great many cumbersome assembly fixtures and also layout work in the shop as far as sheet metal parts and tools are concerned. These are important factors where conservation of space, maximum production, and shop efficiency are desired.

Fig. 5. As the P-39 Airacobra fuselages come off the moving assembly lines, they are ready for attachment of wings.

Shop Assembly

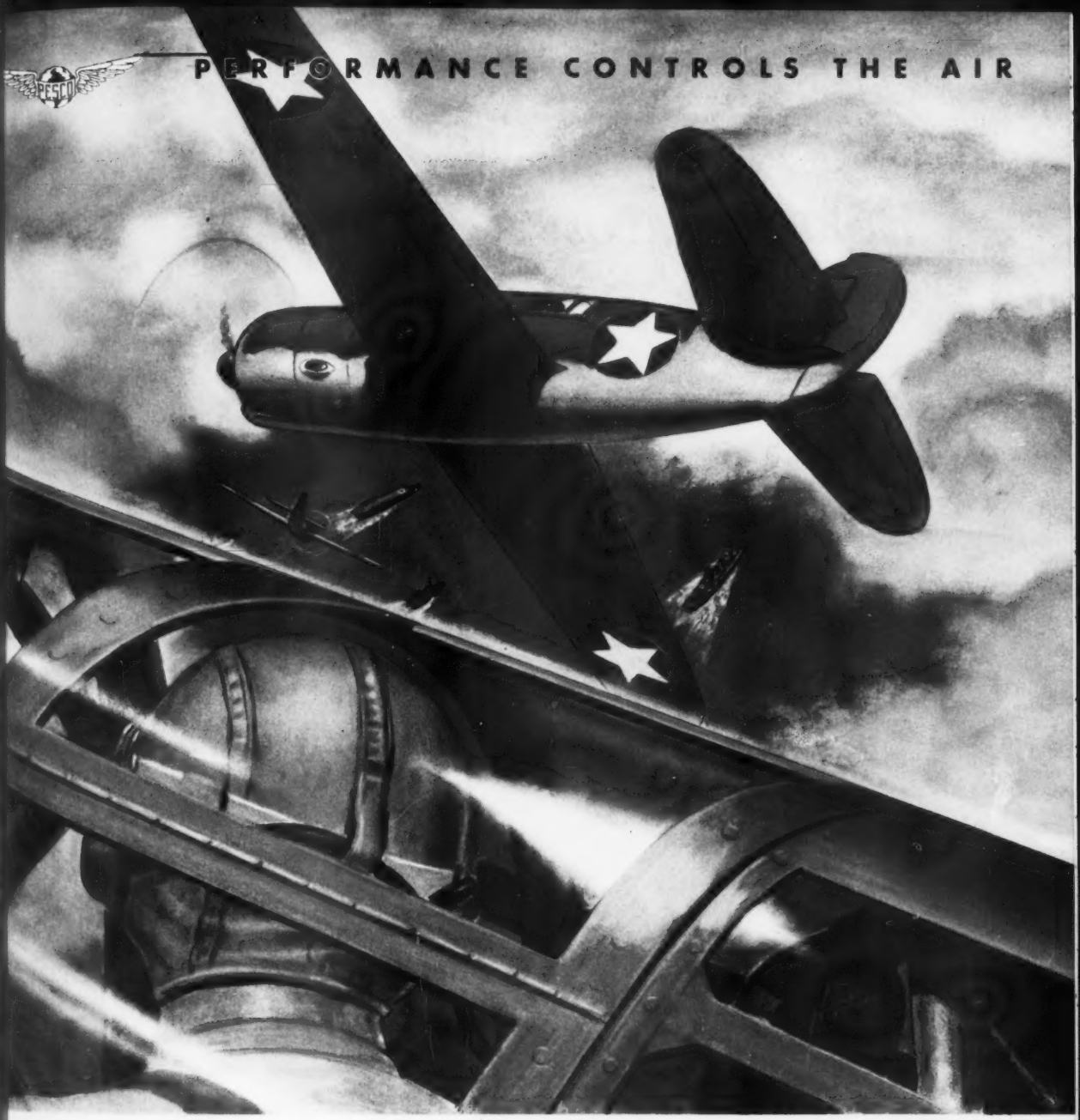
The Airacobra is broken down into five major subassemblies: front fuselage, rear fuselage, outer wing panels, center wing panel, and cabin. These in turn are broken down into several minor subassemblies, each being complete in itself as far as assembly is concerned.

Fig. 5 shows the fuselage of the Airacobra coming off one of the constantly moving conveyor assembly lines, complete in every detail, ready for attachment of the wings, which come off another similar conveyer assembly line and meet the fuselage at this junction; the plane then flies away for delivery to our armed forces.

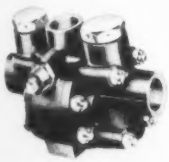
Fuselage Assembly

In its trip down the assembly line, the fuselage passes through several assembly stations. At these stations armament, wiring, piping, motor, aft fuselage, cabin, controls, and the like are added. It should be noted that the equipment, cabin, etc., are located by lofted holes, the only fixtures used being the dollies upon which the fuselage travels. Prior to the journey down the

PERFORMANCE CONTROLS THE AIR



Curtiss Helldiver



PESCO Flow Divider for equalizing hydraulic pressure.

Down they go! Straight down. Peeling off one after another; fingers eager to blast another symbol of hate to the bottom of the sea. With never a thought for themselves, these brave sons of ours pray only that their aim be true . . . that the performance of each plane part be faultless. Here is where the precision of the men who make our planes, and the men who fly them, become a combination that can't be beat!

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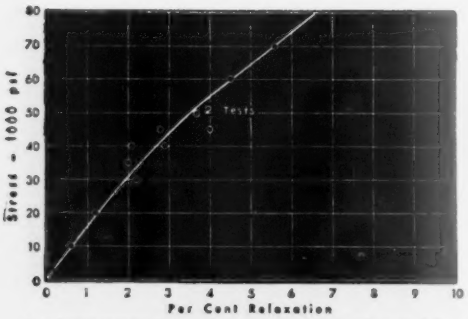
DIVISION BORG-WARNER, CLEVELAND, OHIO

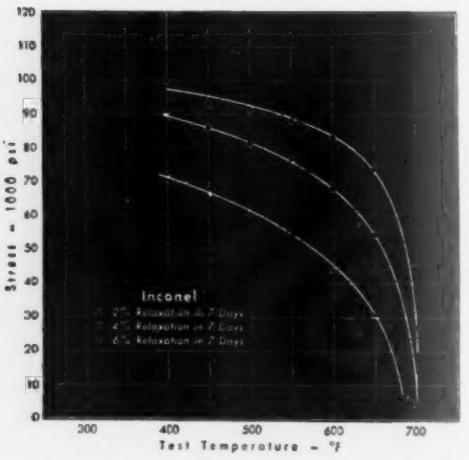
Inconel Springs Hold Load Loss to Minimum At Elevated Temperatures

At temperatures up to 650° F. and under high stress Inconel springs successfully resist relaxation or load loss. Above this point, Inconel still gives remarkable service, though stress must be lowered considerably and some relaxation tolerated.

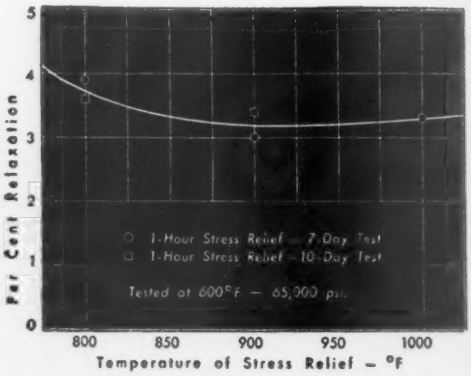
The following tests, made in cooperation with the A.S.M.E. Special Research Committee on Mechanical Springs, graphically show the unique properties of Inconel.



(1) Stress versus Relaxation in 7 days; Inconel at 650° F.



(2) Stress required to produce 2, 4 and 6 per cent relaxation of Inconel Springs in 7 days.


Per Cent Relaxation
1-Hour Stress Relief — 7-Day Test
1-Hour Stress Relief — 10-Day Test
Tested at 600°F — 65,000 psi
Temperature of Stress Relief - °F

(3) Effect of Stress-equalizing Temperature upon the relaxation of Inconel Springs in 7 and 10 days. (Tests run at 600° F. and 65,000-psi stress.)

The springs tested were 1¼ in. OD, 2¾ in. free height and had 6¼ total coils. They were made of 0.148" diameter wire.

The graphs are based on behaviour of these springs loaded to a constant *height*. It is probable that, within stress and temperature limits which would produce not more than 10% relaxation, these results are also applicable to cases involving constant *load*.

Inconel Springs... helical, spiral or flat, of every shape and size... have high endurance limit, good strength, unusual stiffness. Inconel is immune to rust and highly resistant to oxidation and corrosion.

The bulletin "Relaxation Resistance of Nickel-Alloy Springs" reports the tests shown above and gives similar data on the relaxation resistance of Monel, "Z" Nickel and "K" Monel springs. This report also includes curves showing results of tests to determine the best stress-relief treatments for Monel and Inconel springs, and also curves and formulae showing changes in torsional modulus at high temperatures for each of these spring materials.

Copy of the bulletin and additional information on request. Write The International Nickel Company, Inc., 67 Wall Street, New York, N. Y.

★ ★ ★ ★ ★ **INCO NICKEL ALLOYS** ★ ★ ★ ★ ★

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL

Sheet...Strip...Rod...Tubing...Wire...Castings

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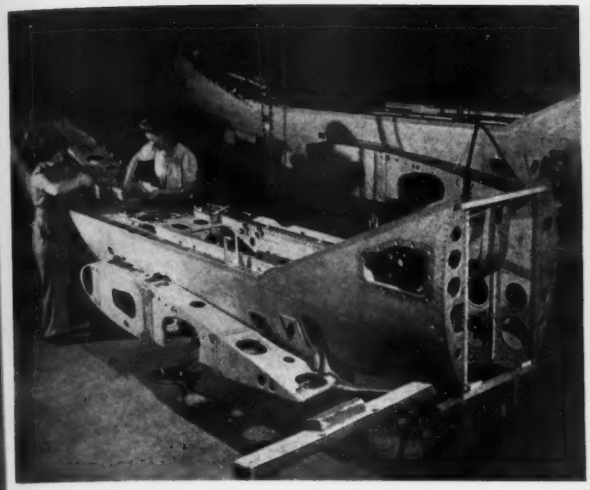

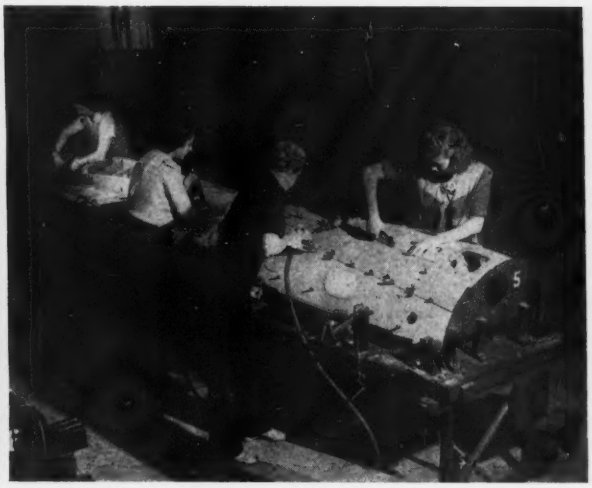

FIG. 6. With lofted deck plates, jigged fittings and wing center section, the two longitudinal beams are joined. The P-39 fuselage is now ready to go on the assembly lines. FIG. 7. With lofted rivet holes, the longitudinal beams are skinned in the assembly process of a P-39 Airacobra.

assembly line, the front fuselage consists of not much more than a shell made up of two main longitudinal beams that run from the junction of the aft fuselage to the reduction gear box at the nose of the airplane. These beams are made up as subassemblies and then tied together by means of lofted deck plates, jigged fittings, and the wing center section (Fig. 6).

Beams

The beams are, with the exception of location and drilling of major fittings, completely assembled with coordinated lofted parts. Fig. 7 shows the skins being applied while the beam is resting in a holding fixture. The skins, which are laid out from flat pattern templates, carry the complete rivet pattern. The bulkhead to which the skins are attached carries, say, approximately 10 per cent of the holes. Assembly of the skin to the bulkheads is accomplished by pinning the parts together with skin clamps through the lofted rivet holes. From the skin the balance of the rivet holes are drilled into the bulkheads. The absence of locating blocks for the bulkheads should be noted. When the skin is thus attached it serves as a fixture or jig to locate the bulkheads. In turn, the bulkheads locate the skin. The simplicity of the holding fixture makes possible clear, uninterrupted work, the structure to be worked on being readily accessible at all times.

Prior to the skinning operation, the bulkheads were added to the beam webs (Fig. 8). For this, only a rack has been provided which holds the beam in an upright position while the bulkheads are attached, drilled, and riveted to the stiffeners on the beam web. In this case, again, only a small percentage of the holes are located in the bulkhead, the complete rivet pattern being in the stiffeners, which again are made from a template. After pinning the two parts together, the bulkheads are drilled from the holes in the stiffeners.

The beam proper is made up from webs plates, longitudinal angles, and tee section stiffeners. For assembly of these parts a fixture is provided (Fig. 9). Because of the fact that at this point jigged holes for motor mounts, landing gear fittings, and the attachment of the center wing panel are drilled, it is necessary to add locators for the longitudinal angles. However, as can be seen in Fig. 10, the sheet metal parts consisting of the web plates, doubler plates, and stiffeners are assembled drilled and riveted on the bench prior to being placed in the fixture. The webs, stiffeners, etc., are tied together with lofted holes.

Each other major and minor subassembly on the Airacobra is assembled in much the same manner as the longitudinal beam. Much of the assembly work and location of parts is being done by coordinated holes drilled or punched into the parts while still in the flat state prior to forming.

FABRICATION OF DETAIL PARTS

The Airacobra has a definite shape, each one is made exactly like the other, even to the smallest detail. Every part is fashioned to a predetermined shape. The shape of the Airacobra is controlled by myriad small sheet metal parts, each of which has been precisely formed and matched one with the other with coordinated rivet holes.

To make just one of these details, such as a bulkhead for the longitudinal beam, requires a number of tools and operations. These tools and operations must be correlated one with another to make certain that the part is correct with respect to shape and rivet hole pattern; this correlation is done with loft templates.

FIG. 8. Bulkheads are assembled on the P-39 longitudinal beam web with lofted holes.

The Plywood Airplane is a *TEGO-BONDED* Airplane

THE COMPLETE RESIN BONDING LINE AT WORK

THE modern plywood plane, such as the Curtiss Commando pictured here, resulted directly from the introduction of TEGO Resin Film in 1935. Use of this pioneer synthetic resin adhesive first enabled woodworkers to make weather-proof, fungus-proof, boil-proof aircraft plywood. TEGO also supplied the key to the problem of producing highest quality aircraft plywood in large quantities quickly.

Today, as for many years past, TEGO-bonded plywood is the accepted standard for aeronautical plywood meeting the rigid requirements of the U. S. Army and Navy Specifications. No other resin adhesive can match the long record of outstanding performance which TEGO has demonstrated. In the construction of practically every plywood plane TEGO-bonded plywood is widely employed.

Photo through the courtesy of Curtiss-Wright Corp.

Tego Resin Film

TEGO Resin Film, a phenol formaldehyde type resin in sheet form for hot pressing, has been, since its introduction in 1935, the standard for highest quality, completely waterproof, hardwood plywood. Its advantages include unquestioned durability and strength of bond, uniformity of spread, cleanliness and precision of operation, absence of glue water, freedom from surface penetration, and speed of output. Today, TEGO Resin Film can add to these advantages a length, diversity and severity of service unapproached by any other comparable plywood adhesive.

The Uformites

UFORMITE 430 is a concentrated solution of a synthetic resin of the urea formaldehyde type. It has extended the advantages of resin adhesives to lower cost fields such as furniture and radio cabinet manufacturing.

UFORMITE 500 is a similar resin supplied as a dry powder. Both UFORMITE 430 and UFORMITE 500 may be used for both hot-setting and cold-setting work.

UFORMITE CB-551, a new cold bonding, urea formaldehyde resin with catalyst included, is characterized by extreme simplicity in use, and quality bonds far superior to older cold-setting glues.

The Amberlites

The AMBERLITES are phenol formaldehyde type resin adhesives, supplied in powder or liquid form. Each AMBERLITE is designed specifically for use in hot pressing several types of plywood.

AMBERLITE PR-14—This liquid resin adhesive is widely employed in the manufacture of aeronautical and marine plywood, and for rubber bag work.

AMBERLITE PR-23 and PR-51—Douglas Fir Plywood Association approved adhesives for use in EXT plywood.

AMBERLITE PR-50—Especially developed for impregnating, compregnating plywood.

THE RESINOUS PRODUCTS & CHEMICAL COMPANY

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FIG. 9. A holding fixture is provided for assembling the P-39 longitudinal angles and drilling for major fittings.

Bulkheads

Fig. 11 shows the bulkhead as it is formed over a steel form block on the hydraulic press. The steel form block used in this case gets its shape from a form block template made in the mold loft. Using an oxyacetylene torch on a pantograph cutter and following the outline of the form block template, the shape for the form block is cut from a piece of boiler plate of suitable thickness, material for bevels and final dressing being allowed. After surface grinding both faces of the plate, holes for steel pins are located by drilling directly from the form block template and the steel pins are set in. With the template located by means of these pins, the outline is transferred to the block with a steel scribe. Using this outline as a guide, the edges of the block are finished to the exact bevel given on the form block template. This is done on a disc grinder. Lightening holes, the centers of which are located from the template, are recessed into the block with a standard fly cutter. By hand filing or other means, the bend radius as noted on the template is added to the edges of the block. It is interesting to note at this point that the bevels noted on the form block template are corrected for spring back, the amount varying, of course, with the gauge of material being formed and the number of degrees through which it is formed.

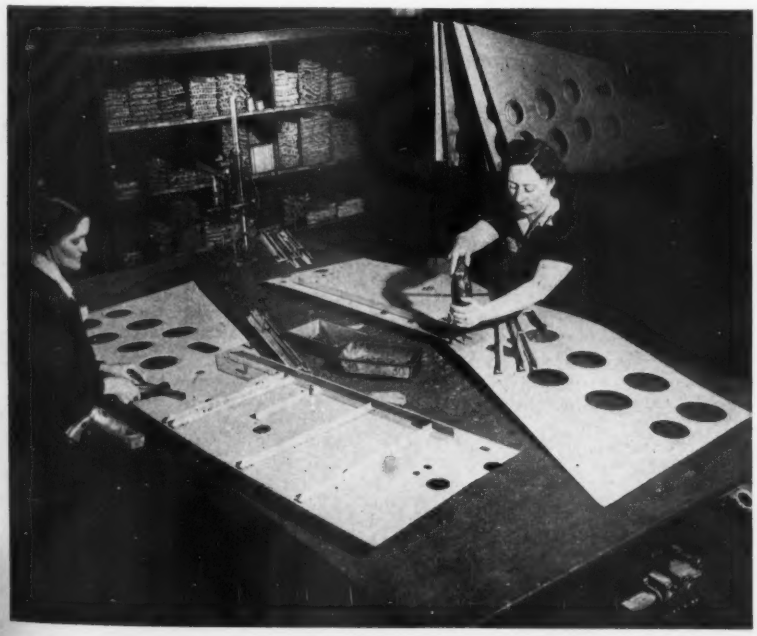


FIG. 10. P-39 beam webs, doubler plates, etc., are assembled and riveted on the bench by means of coordinated rivet holes. No fixture is necessary because of the methods employed.

Inspection of the block is, to a large extent, visual. By simply setting the template over the pins on the block, the outline and location of lightening holes are checked by visual examination. Bevels as marked on the template are checked with a protractor.

To insure that the form block template is made correctly, it is matched with pinholes and the outline is checked with that of the template used to make the tools from which the blank part is made.

FIG. 11. Complete with rivet holes, cutouts and lightening holes, this P-39 bulkhead is shaped over a steel form block on a hydraulic press in the fabrication department.

FIG. 12. Parts for the P-39 are blanked out on a crank press with a template die. The blank is then complete, ready for forming.

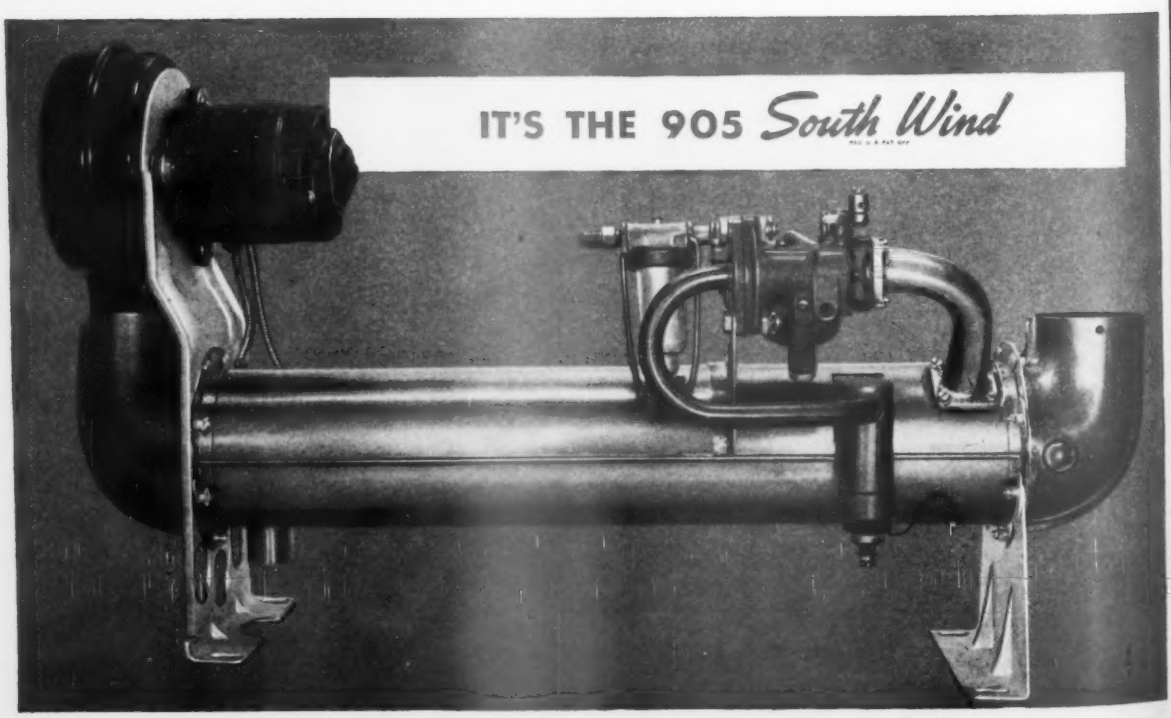
Use of the Template Die

To make the blank part, a template die is used (Fig. 12). The blank part, complete with lightening holes, rivet holes, cutouts, etc., is made in one operation on the crank press. The template die used to blank out the part is made from a developed template. The developed template, as the name implies, is the exact shape of the blank required to make the bulkhead. The template die is made up of a chromium-molybdenum alloy steel punch and die

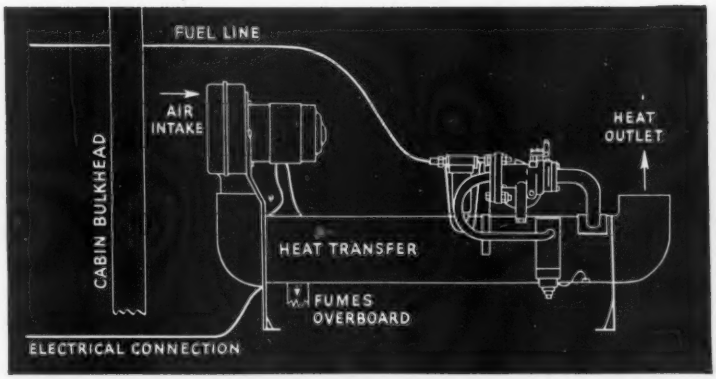
A NEW *South Wind* AIRPLANE HEATER

REG. U. S. PAT. OFF.

...works independently of engine!



DELIVERS "HOT HEAT" on the ground...or in the Air!



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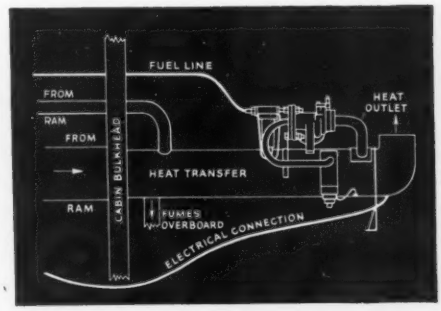
The motor and blower produce heat regardless of whether the airplane is moving or not and can be used for warming or defrosting windows before take-off, for warming cabins in small planes, etc.

It's light in weight. Easy to install —and is practical for any place a gasoline heater could operate.

The new 905 series of South Wind Heaters is available in three versions. One delivers up to 10,000 BTU/hr. and operates on 60 watts . . . on either 12 or 24 volt D.C. Another delivers from 7000 to 8000 BTU/hr. and operates on only 20 watts . . . and 12 volts D.C. A third version delivers 24,000 BTU/hr. as a ram-operated heater, without motor and blower.

Also available for RAM-OPERATION!

OPERATES independently of engine but will not produce heat when plane is not moving. In the air, it will operate up to the maximum speed of any pursuit plane with increased heat output being developed in proportion to the change in speed. The heater, however, does not become hotter as a result. There are only two connections . . . electrical and fuel. The only current used is for starting combustion. Delivers up to 24,000 BTU/hr. at 160 m.p.h. of ram pressure.



Another Product of STEWART WARNER

South Wind Heaters

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ARMY E NAVY

HEATER DIVISION, STEWART-WARNER CORPORATION, CHICAGO, ILLINOIS

West Coast Office: Stewart-Warner Aircraft Heater Engineering and Service, 1273 Westwood Blvd., West Los Angeles, California

The Plywood Airplane is a *TEGO-BONDED* Airplane

THE COMPLETE RESIN BONDING LINE AT WORK

THE modern plywood plane, such as the Curtiss Commando pictured here, resulted directly from the introduction of TEGO Resin Film in 1935. Use of this pioneer synthetic resin adhesive first enabled woodworkers to make weather-proof, fungus-proof, boil-proof aircraft plywood. TEGO also supplied the key to the problem of producing highest quality aircraft plywood in large quantities quickly.

Today, as for many years past, TEGO-bonded plywood is the accepted standard for aeronautical plywood meeting the rigid requirements of the U. S. Army and Navy Specifications. No other resin adhesive can match the long record of outstanding performance which TEGO has demonstrated. In the construction of practically every plywood plane TEGO-bonded plywood is widely employed.

Photo through the courtesy of Curtiss-Wright Corp.

Tego Resin Film

TEGO Resin Film, a phenol formaldehyde type resin in sheet form for hot pressing, has been, since its introduction in 1935, the standard for highest quality, completely waterproof, hardwood plywood. Its advantages include unquestioned durability and strength of bond, uniformity of spread, cleanliness and precision of operation, absence of glue water, freedom from surface penetration, and speed of output. Today, TEGO Resin Film can add to these advantages a length, diversity and severity of service unapproached by any other comparable plywood adhesive.

The Uformites

UFORMITE 430 is a concentrated solution of a synthetic resin of the urea formaldehyde type. It has extended the advantages of resin adhesives to lower cost fields such as furniture and radio cabinet manufacturing.

UFORMITE 500 is a similar resin supplied as a dry powder. Both UFORMITE 430 and UFORMITE 500 may be used for both hot-setting and cold-setting work.

UFORMITE CB-551, a new cold bonding, urea formaldehyde resin with catalyst included, is characterized by extreme simplicity in use, and quality bonds far superior to older cold-setting glues.

The Amberlites

The AMBERLITES are phenol formaldehyde type resin adhesives, supplied in powder or liquid form. Each AMBERLITE is designed specifically for use in hot pressing several types of plywood.

AMBERLITE PR-14—This liquid resin adhesive is widely employed in the manufacture of aeronautical and marine plywood and for rubber bag work.

AMBERLITE PR-23 and PR-51—Douglas Fir Plywood Association approved adhesives for use in EXT plywood.

AMBERLITE PR-50—Especially developed for impregnating, compregnating plywood.

THE RESINOUS PRODUCTS & CHEMICAL COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

FIG. 9. A holding fixture is provided for assembling the P-39 longitudinal angles and drilling for major fittings.

Bulkheads

Fig. 11 shows the bulkhead as it is formed over a steel form block on the hydraulic press. The steel form block used in this case gets its shape from a form block template made in the mold loft. Using an oxyacetylene torch on a pantograph cutter and following the outline of the form block template, the shape for the form block is cut from a piece of boiler plate of suitable thickness, material for bevels and final dressing being allowed. After surface grinding both faces of the plate, holes for steel pins are located by drilling directly from the form block template and the steel pins are set in. With the template located by means of these pins, the outline is transferred to the block with a steel scribe. Using this outline as a guide, the edges of the block are finished to the exact bevel given on the form block template. This is done on a disc grinder. Lightening holes, the centers of which are located from the template, are recessed into the block with a standard fly cutter. By hand filing or other means, the bend radius as noted on the template is added to the edges of the block. It is interesting to note at this point that the bevels noted on the form block template are corrected for spring back, the amount varying, of course, with the gauge of material being formed and the number of degrees through which it is formed.

FIG. 10. P-39 beam webs, doubler plates, etc., are assembled and riveted on the bench by means of coordinated rivet holes. No fixture is necessary because of the methods employed.

Inspection of the block is, to a large extent, visual. By simply setting the template over the pins on the block, the outline and location of lightening holes are checked by visual examination. Bevels as marked on the template are checked with a protractor.

To insure that the form block template is made correctly, it is matched with pinholes and the outline is checked with that of the template used to make the tools from which the blank part is made.

FIG. 11. Complete with rivet holes, cutouts and lightening holes, this P-39 bulkhead is shaped over a steel form block on a hydraulic press in the fabrication department.

FIG. 12. Parts for the P-39 are blanked out on a crank press with a template die. The blank is then complete, ready for forming.

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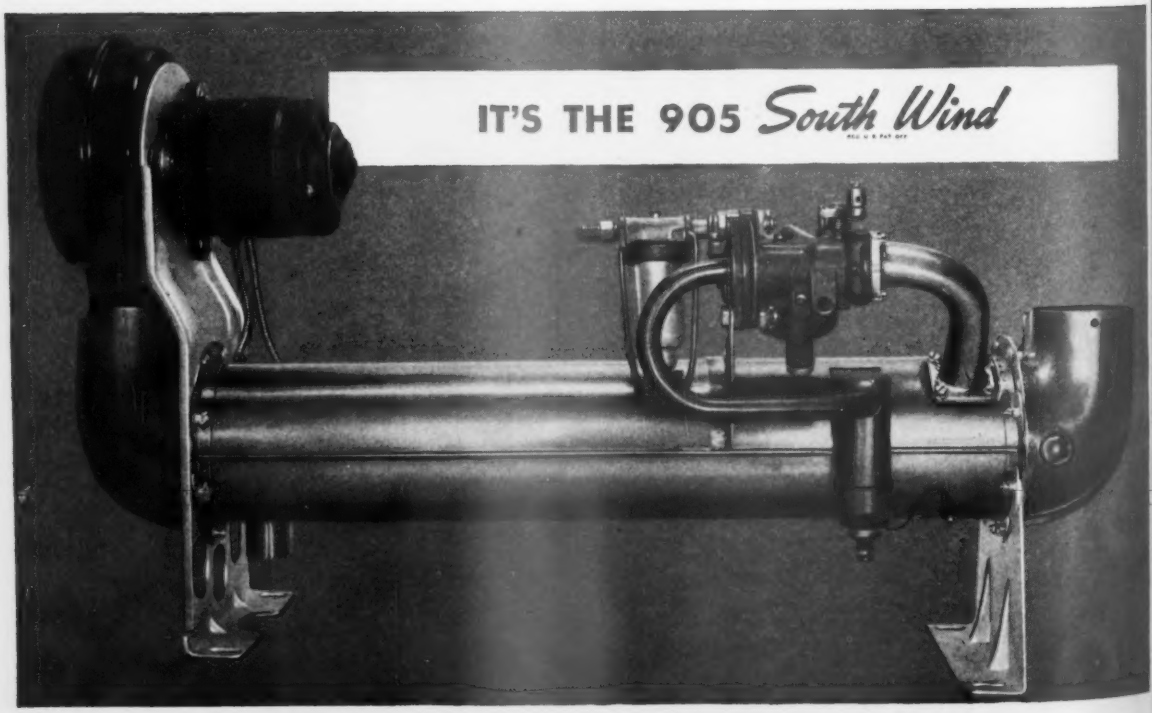

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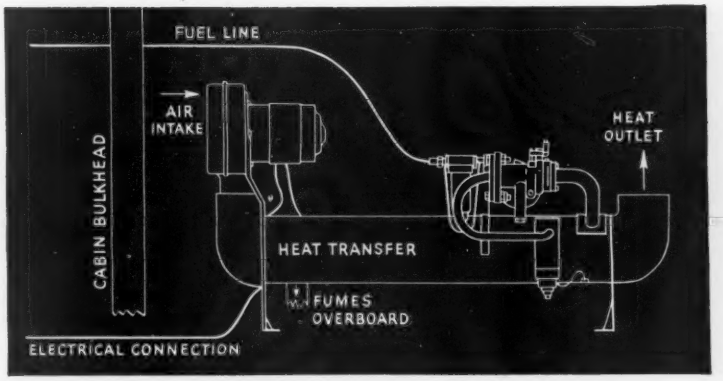

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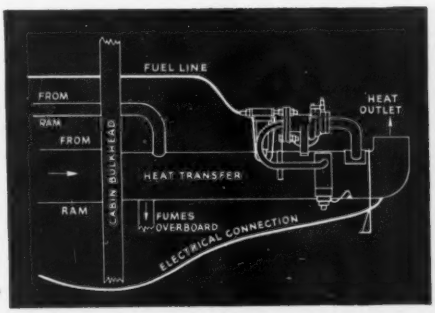

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West Coast Office: Stewart-Warner Aircraft Heater Engineering and Service, 1273 Westwood Blvd., West Los Angeles, California

Another great contribution to the conquest of the air

radar and the electronic vacuum tube have scored a victory in man's conquest of the air. No longer need the pilot grope his way, no longer need fog and storm present so great a hazard to man's flight. Radar is an electronic device which by transmitting a rebounding beam enables one to virtually see through the darkness, storms and fog. Mid-air collisions, crashes into mountain sides, and other obstacles which may be in the path can be discerned miles ahead. Radar is probably the most important contribution to man's conquest of the air since the Wright brothers took off at Kitty Hawk. Vacuum tubes are the heart and soul of this equipment.

The usefulness of the airplane has been greatly advanced by the electronic vacuum tube. And Eimac tubes in particular have played an important role. First in airline ground stations, first in instrument landing devices and today first in military radar. Yes, Eimac tubes and Aviation are old friends. Out of this friendship comes a combined experienee of great value to future progress.

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ARMY E NAVY

Eimac 304T tube

mounted on boiler plate. To make the punch, the outline of the developed template is transferred to a chromium-molybdenum plate by tracing around the template with a steel scribe. Rivet holes, centers of lightening holes, pinholes, and the like are drilled directly from the template. Following the scribed outline, the punch is cut out on a band saw and finished on a disc grinder. The punch is then cyanide-hardened. The die is made by rough cutting a chromium-molybdenum plate approximately $^1/_{32}$ in. under the outline of the template and trimming to the exact outline by forcing the hardened punch through the die on the hydraulic press. The edges of the die are relieved by hand filing.

The punch and die are then mounted on separate pieces of boiler plate by tack welding. Rivet holes are transferred to the backup plate on the die by drilling directly through the punch. Punches for rivet holes are set in the backup plate for the die. Rubber pads are added for stripping the blank and the scrap. From a master plate holes for mounting on the crank press are added, thus assuring absolute interchangeability on any of the crank presses used at the Bell Aircraft factory.

Except for special cases the form block and template die such as the ones just described are used almost exclusively for blanking and forming sheet metal parts on the Airacobra. It can readily be seen that with this type of tooling, layout work and use of drawings have been eliminated in the toolrooms. With the aid of templates almost any fair mechanic can make a hydropress form block or a template die, thus conserving the first-class toolmakers and diesinkers for the more complicated work in the toolroom. Tools of this nature are readily made and cheap. They can, if necessary, be reworked or even replaced without a great deal of expense or lost time, yet they will stand up for runs of from 20,000 to 50,000 parts. The ruggedness of a template die is demonstrated when the punch is forced through the chromium-molybdenum plate to make the die.

Blanking

In blanking parts which because of their size or gauge cannot be made on the crank presses with template dies, a pantograph router is used (Fig. 13). On this machine parts are stack-drilled and routed out of sheets stacked one on top of the other up to $^1/_2$-in. thickness. This machine consists of two parallel tables, one on which the material for routing is mounted and one for mounting the templates. The pantograph router is unique in itself inasmuch as the stack drilling and routing are accomplished without the template ever coming in contact with the work or having to be moved at anytime during the operation of stack drilling and routing. Examples of parts made on the pantograph router are the long fuselage skins as seen in Fig. 7.

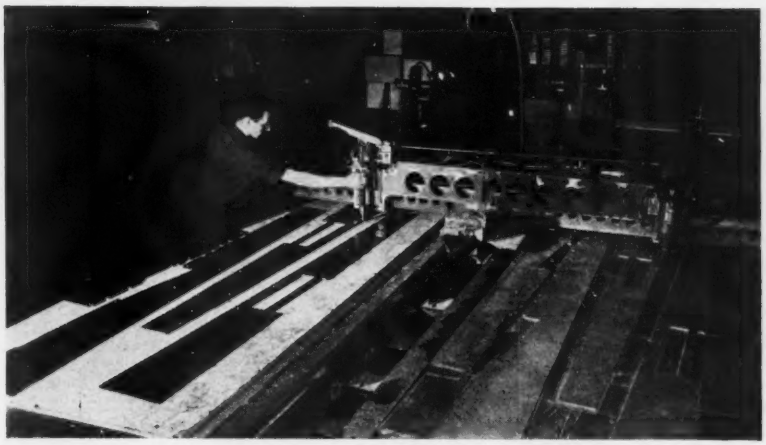

FIG. 13. Aircraft pieces too large for the crank press are routed out on pantograph routers.

As a guide for the stylus on the pantograph router, a router template is used. Except for the fact that it carries less information and is mounted on $^1/_4$- or $^1/_2$-in. plywood base for ease in following with the stylus, it is an exact duplicate of the developed template.

Drop Hammers

To form parts such as wing fillets, cowling, and the like which are too large to handle on the hydropress, drop hammers such as the one in Fig. 14 are used. The drop hammer dies, which usually consist of a zinc die and lead punch, are cast from a pattern that is set up with a series of contour templates. The parts that are formed in the drop hammer usually carry an excess of stock which has to be trimmed after forming. This is done with an apply template that has been shaped to fit over the part. The apply template is made by placing a sheet of automobile body steel in the die and forming it. In conjunction with the engineering prints and the contour templates, the steel thus made is trimmed to shape in the loft and holes are added for rivets, cowl fasteners, etc. (Fig. 15). The apply template is placed over the formed parts, and the parts are trimmed to shape on a conventional pin router, rivet holes and the like being drilled with a portable drill motor.

FIG. 14. Drop hammers are used for parts too large for the hydraulic press. Apply templates are made by forming a piece of steel in the drop hammer die.

Master Contour Plates

To make certain that the developed template, form block templates, router templates, and countour templates are made exactly for outline, master contour templates are used. The contour templates are made to fit the outline or contours of the body plan. Reference lines such as centerline of airplane, horizontal reference line, beam intersections, longitudinals, and stringers are transferred directly from the body plan to the master contour templates. Flange angles or bevels are also picked up from the body plan and noted on the templates. The master contour templates are for the exclusive use of the loft, never being allowed in the shop. However, for shop use in setting up plaster patterns, checking drop hammer dies, and erecting steel holding fixtures, a duplicate set of contour templates are made.

Inspection

Inspection of detail sheet metal parts is, to a large extent, visual, requiring only that the part be matched to the template by means of the pinholes and the outline and location of lightening and rivet holes compared to the template, while flanges and flange angles are measured with a steel scale and protractor. Information on the templates is adequate for the inspection work, reference to blueprints being unnecessary.

When a loftsman makes a template or group of templates, he takes many factors into consideration. He must make certain that the part can be made, as planned, with the tools provided. He must see that rivet holes are so located that they are accessible to the shop workman. In short, he must put himself in the place of the shop work-

Why P

Rapid Fabrication of Large Parts

Molding has always been one of the fastest and most economical methods of producing plastic parts in quantities. But through a recent development of Bakelite Laboratories—Heatronic Molding—the technique of molding has been accelerated still further. Heatronic Molding employs electrostatic heating of thermosetting materials, so that heat is generated uniformly *within* the charge of molding material by high-frequency current. Curing time can be reduced 10 to 50 per cent, and molding pressures lowered by 30 to 40 per cent. Large-sized parts never before possible can now be produced on standard presses. For the first time, the compression molding of pieces thicker than ⅜ inch from thermosetting materials becomes commercially practicable. And, now, the impact-type phenolic plastics can be molded as readily as the general-purpose phenolics.

Manufacturers will immediately recognize the opportunities this process offers in the production of such large equipment as washing machines. The entire tub-and-gear housing could be completely formed as one unit, in a single operation, using the same sturdy and water-resistant plastic adopted for washing machine agitators. It would be strong and durable, yet light in weight. It would have highly desirable heat-insulating characteristics, and would be inert to caustic solutions.

TOUGHNESS for thin sections...

The development of plastic bayonets for Navy training purposes demonstrates the high tensile strength and flexural strength obtainable even for thin-walled parts when they are molded from BAKELITE Molding Board Materials. These impact-resistant plastics are supplied in sheets of various sizes, or in shapes cut to the approximate design of the finished parts. The blanks, as they are then called, are virtually preforms, which can be used in molds designed for general-purpose phenolics. Products can be made entirely from these materials, or the molding boards and blanks can be used with standard types of phenolic plastics to provide reinforcement at vital points.

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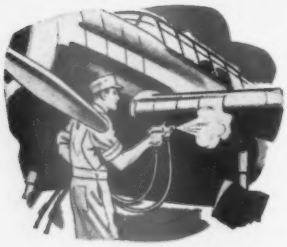
LOW-COST metal replacement...

By adapting the plastic printing plate development of Bakelite Laboratories to the production of instrument control panels, one manufacturer is conserving impressive quantities of precious sheet aluminum and even more precious man-hours. A matrix of BAKELITE Phenolic Material is made from an etched copper plate, which serves as the original pattern. Any number of VINYLITE Plastic panels can be molded in this matrix, complete in every detail, and ready for subsequent curving to final shape by heat treatment. The combined use of these two materials assures faithful reproduction in one operation of not only the intaglio lettering, but also the hundreds of through-holes in the panel. It eliminates many operations necessary with metal plates, such as drilling, engraving, slotting, forming, anodizing, and polishing. *(Panels molded by Theo. Moss & Co., Inc.)*



DURABLE coatings that dry in minutes..

By the addition of BAKELITE Dispersion Resins to paint and varnish formulations, drying time can be reduced from hours to minutes. Such coatings, used by the Navy for more than 8 years as anti-corrosive aircraft primers, air-dry in 1 to 5 minutes without blistering or wrinkling, but nevertheless exhibit remarkable durability. Primers based on these resins and exposed, without top coat, for 2½ years on steel panels, revealed no checking or rusting. They have withstood 1,080 hours in a 3 per cent salt solution spray test, while other high-quality primers failed in 90 hours. They have shown no blistering, pimpling, or rusting after 8,000 hours of continuous immersion, whereas other primers failed in 300 hours.

Helpful Literature on Plastics

These are a few of the valuable guidebooks you can obtain by writing to Department 27. "A Simplified Guide to Bakelite Plastics" is a 16-page summary of the principal BAKELITE Plastics now available. It describes each type briefly, and illustrates typical applications. "Bakelite Molding Plastics," a 32-page booklet, provides further information, and ASTM data, on moldable plastics. "Molding Technic for Bakelite and Vinylite Plastics," price $3.50 postpaid, is a 224-page manual on the art of molding plastics—contains comprehensive data that the designer, engineer, molder, and user should have on the design and fabrication of hot-set and cold-set molding materials. Additional pamphlets and booklets describing other types of BAKELITE Plastics are also available.

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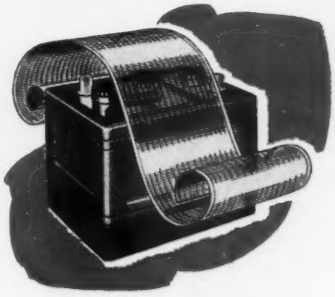
Plastics ?

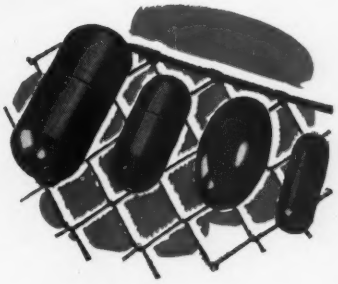
Remarkable DURABILITY for wood...

Stronger and lighter than metal, yet unaffected by extremes of heat or cold, oil, gasoline, and constant vibration, wood impregnated with BAKELITE Resins and molded into three-dimensional forms has become a most valuable structural material in the building of aircraft. Engine cowlings that resist high heat are representative of the many large shapes now molded from wood impregnated with BAKELITE Resin. Entire fuselages and wings can be formed. Sections as long as 84 feet have been successfully produced in torpedo boat construction.



RESISTANCE to corrosive chemicals...

BAKELITE Polystyrene Plastics, in the form of flexible sheeting, are now employed as storage battery separators. Like all other forms of this amazing plastic—molding materials, extruded rods, tubes, and filaments, and resins for surface coatings—the flexible film is unexcelled in its resistance to both alkalies and non-oxidizing acids. Other outstanding advantages of BAKELITE Polystyrene Plastics include: extreme lightness in weight with good mechanical strength characteristics, superior electrical insulating qualities particularly at high frequencies, and high index of refraction when crystal-clear types are employed.



Unusual water RESISTANCE and strength...

Because they are tough and flexible enough to withstand pressures encountered at underwater levels as deep as 1,000 feet, BAKELITE Polystyrene floats are able to release for other service the galvanized steel sheets formerly used to buoy commercial fishing nets at sea. The polystyrene material is extremely resistant to constant immersion in salt water, and also withstands the chemical solution used in cleaning and renovating the nets.

HARDLY A DAY PASSES but another new industrial development is made possible through plastics, or the usefulness of old, familiar products is increased by these versatile materials. **Look** for the reason and you'll find that the trend to plastics is much more than a matter of replacing other materials. It's because plastics frequently provide a better product, and generally one that is also more rapidly and economically fabricated.

Certain BAKELITE Molding Materials, for example, can give your products high mechanical strength approaching metals—with only a fraction of the weight of metal, and no need for time-consuming finishing. They can provide inherent corrosion resistance, electrical properties, heat resistance, color, transparency, translucency, or opacity. And a new molding technique now permits large parts to be molded at high speeds and in greatly increased sizes never possible before.

Wood becomes a stable and amazingly strong material when bonded or impregnated with BAKELITE Resins . . . releases steel in building construction . . . can be molded into heat-resistant and weather-resistant forms of varied shapes and sizes. Surface finishes fortified with one type of BAKELITE Resins dry within a minute or so, yet stand up in service far longer than many other high quality coatings that require hours to dry.

But these are only a few of the plastics developments now available to industry, and merely a suggestion of the vast opportunities they offer to designers and engineers. You can keep posted on plastics by keeping in touch with Bakelite Plastics Headquarters. Our Engineering Staff and Development Laboratories offer their full co-operation in helping you adapt a growing variety of plastics and resins to your essential needs. As a first step, write for the helpful literature shown here. Please address Department 25.

BAKELITE CORPORATION, 30 E. 42ND ST., NEW YORK
Unit of Union Carbide and Carbon Corporation

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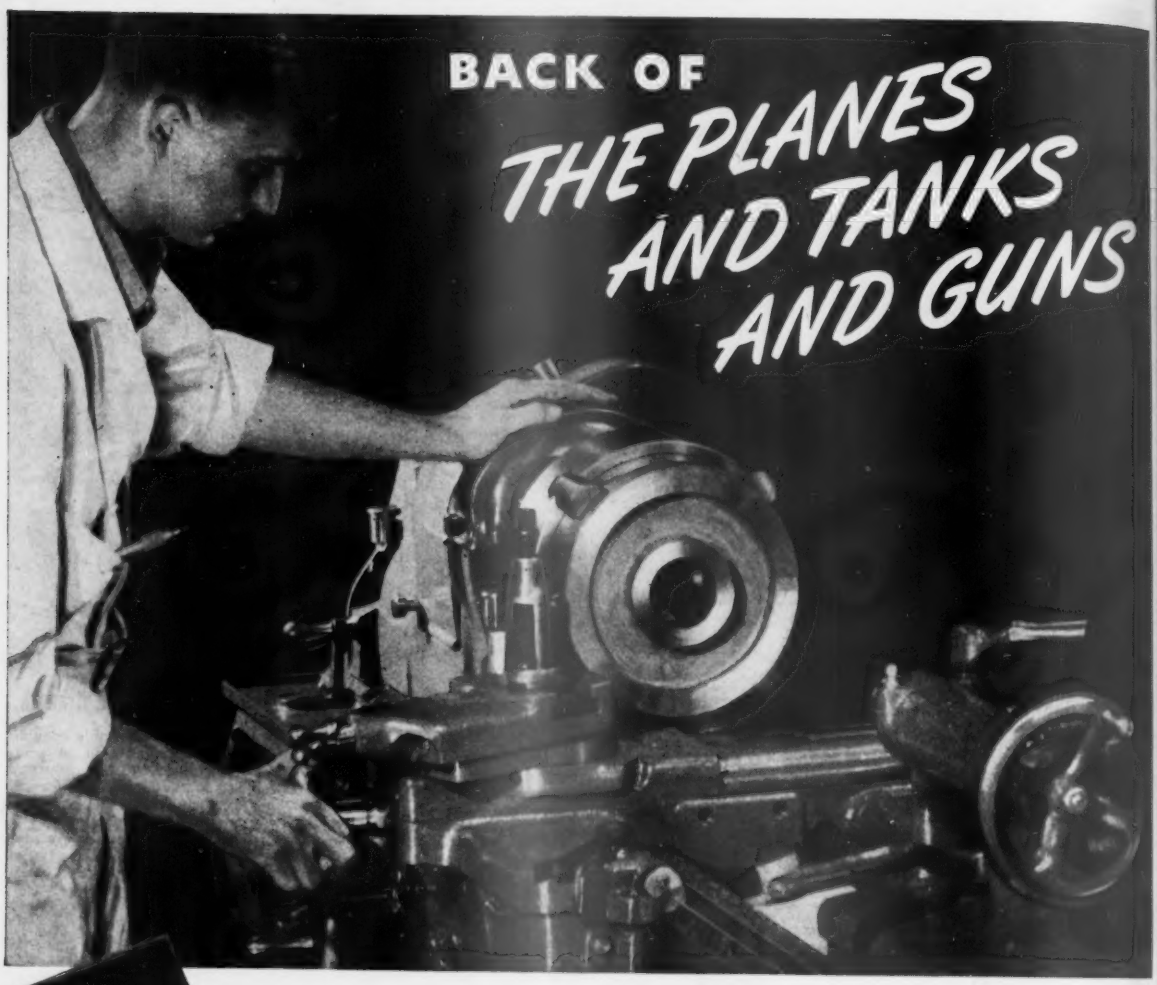
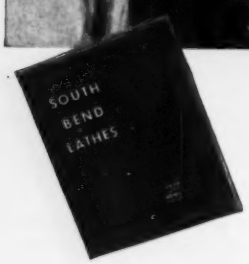
PLASTICS HEADQUARTERS





All of the South Bend Toolroom Lathes, Engine Lathes and Turret Lathes are described in Catalog 100C. Write for a copy of this new, 48-page catalog.

Buy War Bonds!

Army-Navy Production Award With Two Stars

Back of the planes and tanks and guns that are flowing in ever-increasing quantities to our fighting forces is a skillfully coordinated plan of men and machines — a combination of skill, ingenuity and mechanical perfection that is going to win.

Accuracy is the key to the success of this great plan. Without the split-thousandth tolerances that assure perfect interchangeability of parts, the production goals could not be attained —and not enough planes and tanks and guns would reach the war fronts.

Capable of fulfilling the demands of urgent war production, South Bend Lathes have the accuracy and speed for the most exacting precision operations, plus ruggedness and power for efficient service.

South Bend Lathes are made with 9″, 10″, 13″, 14½″, and 16″ swings in both Quick Change Gear and Toolroom models. Practical attachments are available for special classes of work.

SOUTH BEND LATHE WORKS

SOUTH BEND, INDIANA — LATHE BUILDERS FOR 36 YEARS

man and try and anticipate his troubles and needs and provide for them.

The quantity of parts to be made usually dictates the number and type of tools to be used. With more parts to be made, more elaborate and more costly tooling is often practical. This, of course, is not true where templates are concerned. Templates are made the same and in the same quantities regardless of the quantity of parts to be made.

Subcontracting

For work to be done outside Bell Aircraft Corporation, duplicate templates, identical to those used at Bell, are furnished, thus insuring that the parts and/or tools when received from the vendor will be identical to those made at Bell. Here again, much time is saved, inasmuch as the vendor need not do any layout work and need not spend time trying to interpret drawings, many of which, because of the different systems used in the various factories, are foreign to him.

Having laid out at full scale practically every part in the airplane, the loftsmen have proved to be invaluable aids to the shop where troubles are encountered, be it tooling, fabrication, or assembly of parts. Often, without even the use of a scale, the loftsmen are able to locate and remedy troubles in the shop and are called upon quite frequently.

Conclusions

Use of 100 per cent lofting has done a great deal toward speeding up the production of Airacobras.

FIG. 15. Apply templates made in the drop hammer die are used in trimming and drilling the drop hammer parts.

In summation it has:

(1) Provided the shop workmen with accurate patterns that are easy to read and use.

(2) Eliminated entirely, as far as the airplane itself is concerned, blueprints in the shop.

(3) Eliminated, almost entirely, drill fixtures for sheet metal parts besides at least 30 per cent of the assembly fixtures needed heretofore, thus providing more floor space for the assembly work.

(4) Made possible the efficient use of vast numbers of inexperienced men and women on fabrication and assembly work.

(*Continued from page 47*)

hills and over rough terrain, night driving, and other driving problems. The student learns not only operation but maintenance and proper loading of his vehicle.

New Courses

Recently, two new courses were instituted at Chanute Field—hydraulics and instrument (Link) flying trainer maintenance.

The purpose of the hydraulics course is to train selected enlisted men to perform first, second, and third echelon maintenance of aircraft hydraulic systems. These range from the relatively simple systems used on smaller craft to the complex network of pipes, valves, and pumps found on the large bomber. Hydraulic test stands are used to check the operation of various units. Units in the system are completely disassembled, inspected, and adjusted when necessary. Among the airplane hydraulic systems studied are those on the P-40, AT-9, A-20, B-25, B-26, P-38, P-47, and B-24.

While maintenance of instrument flying trainers is a part of the Link trainer instructor course, it is not given as a thorough study of maintenance problems; nor are instructors expected to service the trainers except in emergencies. The new course will train selected graduates of the instructors course for first and second echelon maintenance of the trainers. The course begins with a study of the electrical system, including rectifiers, transformers, and elementary type vacuum tubes; simple amplification and oscillator circuits; and the telegon, telechron, and autosyn systems.

The second phase calls for a study of the wind-drift recorder and radio simulating interphone amplifier; the third provides a detailed analysis of all unit assemblies; the last is a complete study of all maintenance and trouble shooting.

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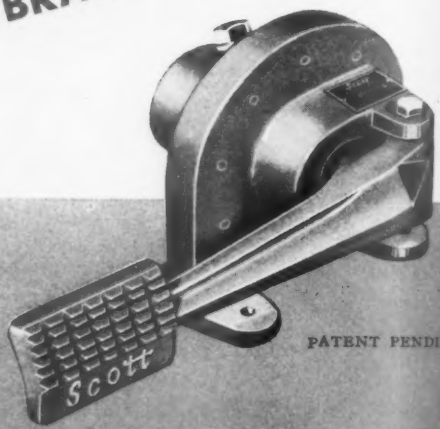
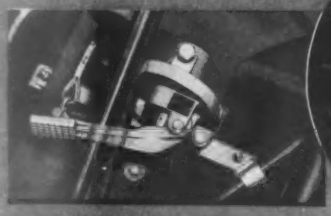
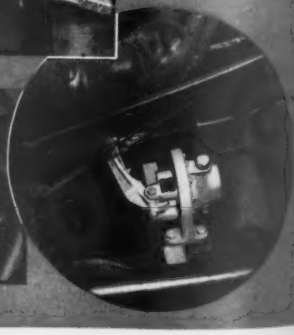


PATENT PENDING

The illustrations below show the locating and simple method of installing the pressure unit in the brake system: (1) Installation on Piper J-3 with floorboards removed showing method of reinforcing and attachment to structural members of fuselage. (2) Close up of left-side pressure unit showing cable extension to front seat brake pedal and attaching clamps. (3) Convenient arrangement of pressure unit pedal, located for easy, positive operation.





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SUPPLIERS TO THE U. S. ARMY AND NAVY AIR FORCES AND LEADING AIRCRAFT MANUFACTURERS

Designing Aerodynamic Surfaces by the Use of Algebraic and Trigonometric Functions to Permit Easy Manufacture

J. J. APALATEGUI* and W. B. WHITE†

Douglas Aircraft Company, Inc.

Introduction

It is interesting to speculate, in general, concerning the shapes of natural objects, to attempt an analytic definition of those shapes, and to discern, if possible, causes creating them. Compared to the unlimited variation in shape of natural objects, the range of deviation of shape from a mean is generally narrower for man-made products and finally reaches, when modern machine technique and mass production methods have developed, a nearly irreducible minimum. When this precision of shape has been attained, it becomes possible, for the first time, to formulate in mathematical language the description of the form of a fabricated article.

Factors Influencing Design

The engineer in designing the shape of an object can find definite reasons for creating one particular shape, since those reasons are based on the effect of the shape of that object on the interaction of that object with other objects. The reasons behind a given design may be aesthetic, which might conceivably be given an abstract mathematical formulation involving probability, or the factors influencing design may be entirely mechanical, in which case the problem of design may always be mathematically stated, even though the solution may be impossibly complicated. But whether or not the ideal shape of the item can be solved for, the shape finally chosen must be completely and precisely described before mass production can begin.

Manner of Description

The manner of this description may be some lines and numbers, a blueprint, a table of offsets, a sample part, a template or master pattern, or even the dimensions of the tool to make the part; but the more complete and, in general, the more mathematical this description is, the more the fabrication process may be broken up and distributed among different tools and different processes, each bit of work being definite and unvarying and therefore independent of the definite and unvarying preceding bit of work performed on the same part. Once the desired end product is analytically defined, the entire scheme of fabrication can be detailed, each operational step planned, and every necessary tool built and ready for use.

John J. Apalategui

Wayne B. White

An obvious comparison between a nonmathematical and a mathematical technique is that involved in the manufacture, only two centuries apart, of a sword and a propeller blade: the sword, a chainwise end result of such intangibles as the appearance of an ore, the shade of the glow of a furnace, the strength of an arm; the propeller, the predictable result of pages of data almost completely numerical.

Shape Precision

First, in the automotive industry and, lately, in the aircraft and shipbuilding industries, notable success was attained by demanding shape precision, with the accompanying benefits of interchangeability and standardization, and by the use of the breakdown, which is of course impossible without complete determinability of shape and dimensional integrity. It is only the complete and precise definition of the shape of the fabricated entity that has realized the present tremendous division of effort and greatly increased production schedule.

Methods of Surface Description

The precise definition of the shape of a body—the shape of necessity meaning the configuration of all the external and internal surface of that body—can be made in two general manners. Either that surface is described by a manifold of points so closely spaced that there is no appreciable change of characteristics of the surface from one point to the adjacent, or the surface is defined by a knowledge of the three-dimensional mathematical functions that describe the location and behavior of the surface at any point. This is not always immediately apparent. It would be interesting to cite examples of each.

Nearly all machined parts, since they are made on machinery that moves, of course, in a known manner—that is, whose paths of motion are known geometric curves—are of necessity defined by mathematical functions. They are combinations of the simple shapes that machine tools can produce: planes, cylinders, cones, spheres, and cylinders

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Presented at the Airplane Design Session, Eleventh Annual Meeting, I.A.S., New York, January 25–29, 1943.

* Project Engineer, Basic Calculations and Lofting Procedures.

† Group Leader, Basic Calculations.

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and surfaces of revolution whose two-dimensional sections are circles, spirals, and cycloids. They are conveniently described by the geometry of the blueprint. Exceptional machined parts whose shapes are not necessarily analytic may be produced with a Keller, a Hydravari, or any such machine following a handmade pattern. In general, however, most machined surfaces are defined by mathematical functions. Most cast and forged parts also fall in this class, since they are generally described geometrically by blueprint and since the only convenient shapes are the elementary plane, cylinder, cone, sphere and torus. Even these simplified surfaces can be usefully given explicit metric description at least at some stage of their production, in some consistent analytic frame of reference.

Designing Machine Parts

In the design of machined parts it is easy for the engineer to develop many of the details of his design while the drawing is proceeding. He will frequently dimension one part or element by relation to an element already drawn, then another element by relation to that one, and so on. But at one stage in making the tools for the production of that part, either that same step-by-step layout must be repeated by a template or patternmaker, or time must be spent in calculation to arrive at data referred to a common set of reference axes which will be directly useful to the tool designer or the machine operator making the prototype or master part. For certain phases of tooling the best description is that of analytic geometry—angles and distances measured from well-defined coordinate axes.

Surface Description

The second manner of surface description—that is, by means of a manifold of closely spaced points—is frequently used for complicated shapes and formed sheet metal parts. The location of these points may be tabulated numerically or in a table of offsets, or they may exist only as a sample or master part or as a number of lofted lines defining a three-dimensional surface by a number of two-dimensional cross sections taken through it. (Technically, a three-dimensional pattern is a manifold of points spaced infinitely close, describing a surface that probably has no analytic definition.) The table of offsets and full-scale frame lines are common in shipbuilding; the solid pattern is common in automobile building; the loft board and plaster pattern are commonly used for cowl, duct, fillet and other complex shapes in aircraft tooling. Analytically, they have the common fault of usually being indeterminate. If the loft boards or patterns were destroyed, new ones would not exactly duplicate the previous, and to convey a description of a part to another location means the transit of an actual part or pattern.

Many engineered structures are so complicated in shape that this latter method of description by points is the only one possible, but a surprising complexity of shape can nevertheless be defined by function—that is, by mathematical equations or statements.

Conic Sections

Probably the first mathematical material to be tapped for use in the design of the external shape of airplane structures was the mass of work on conic sections which has accumulated over the last 2,200 years. The common geometric and mechanical constructions giving either a parabola, an ellipse, or hyperbola have been useful drafting-room practices. In considerable use has been the general conic construction, based on Pascal's Theorem, concerning the collinearity of the three points of intersection of the opposite pair of sides of an inscribed hexagon. But the specific use of the synthetic and metric properties of conic sections for the design of determinate shapes is relatively new.

The Pascal Theorem

We may first note the Pascal Theorem mentioned above since it is of prime importance in the study of conics. It is diagrammed in Fig. 1 and may be stated as follows: the points of intersection of the three pairs of opposite sides of any hexagram inscribed in a conic lie in a straight line. (A hexagram is a closed sequence of six lines joining any six points in the order 1-2-3-4-5-6-1. It is a general sort of hexagon, whose sides may intersect within the closed figure.) The most frequent application of the theorem is its use in obtaining an unknown point, say 6, on a conic when five points on a conic are known. In this case only one of the pairs of opposite sides of the final hexagram is known, but through its point of intersection, P, can be drawn an arbitrary Pascal line on which the other two intersection points Q and R must lie; thus the whole configuration is made and the unknown point 6 is obtained. As the Pascal line is moved, other points of the conic are obtained until it is defined by as many discrete points as desired. The properties of the configuration may be built into a machine that will construct a continuous conic curve obeying the conditions given. Another construction is available which will give the point of intersection of a conic with any given line.

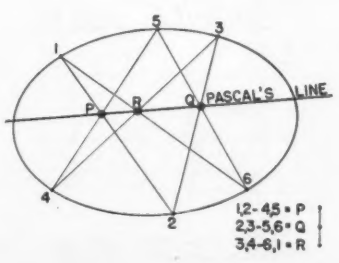


Fig. 1. Diagram of the Pascal Theorem.

Determining a Conic Curve

It is seen that five arbitrary points have been used to define a conic curve. This is a special example of the five variable conditions necessary to determine the five variable coefficients of the general second-degree equation

$$Ay^2 + Bxy + Cx^2 + Dy + Ex = 0$$

which may be rewritten in the form

$$y = cx + d \pm (ax^2 + bx + e)^{1/}$$

Some of these five points may coalesce so that, where two have merged, two conditions—a point and a slope—are determined at the double point; or three points may approach, in which case three conditions—point, slope, and radius of curvature—are determined at the triple point. Any of the five following sets of five conditions then determine a unique conic curve: (1) five points, (2) three points and a point-slope, (3) two points and a point-slope-curvature, (4) one point and two point-slopes, and (5) a point-slope and a point-slope-curvature.

The hexagram configuration and the Pascal line for the fourth case are shown in Fig. 2. It is evident how the convergence of the points has simplified the geometry of the construction. In short, given any set of geometric conditions of a complexity ample to determine a conic section or special conic section (parabola or circle), that conic may be easily constructed; also constructible are the points of intersection or tangency with other conics or with straight lines.

Analytic Treatments

At the same time, the analytic treatment of conics has been developed so that any problem may be answered by

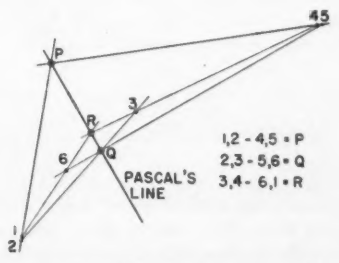


Fig. 2. Pascal line for one point and two point-slopes.

construction or equation in approximately the same length of time. Fig. 3 shows typical tabulations for writing a simple conic equation.

It has been found that a combination of both graphic and analytic treatment of curves is advantageous. The graphic methods are more useful for preliminary design, reduced scale layout, and the actual lofting of portions of curves not excessive in size—such as fillets, wing-tip cross sections, and body-plan sections of fuselage and nacelle shapes on small aircraft. When the curves become too large for ordinary layout methods, it is more satisfactory to write the curve equations and lay down the shape from calculated offsets. Lines that are used as longitudinal control lines and which do not appear on any template—such as fuselage top and bottom profile, maximum half breadth and side control lines—should be determined entirely by calculation rather

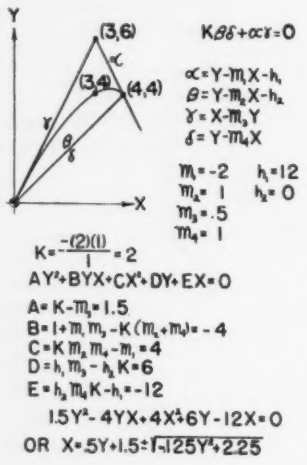


Fig. 3. Typical tabulation for writing a simple conic equation.

than layout. Figs. 4, 5, and 6 illustrate a simple shape development by the use of mathematical control lines and, for comparison, the older methods of buttock and water-line fairing and a typical key system fairing method. (A key system is a method of projective distortion.) When the entire external surface is developed mathematically, it is unnecessary to make, on board or template, any layout larger than the largest piece of frame or sheet of skin which will be used in the fabricated assembly.

Power Curves

We have seen that a conic curve may be defined by a point and two point-slopes; that is, it may start from a given point with a given initial slope, pass through a control point, and end at a third point with a given slope. It is therefore possible to piece together two or more sections of conic arc, each

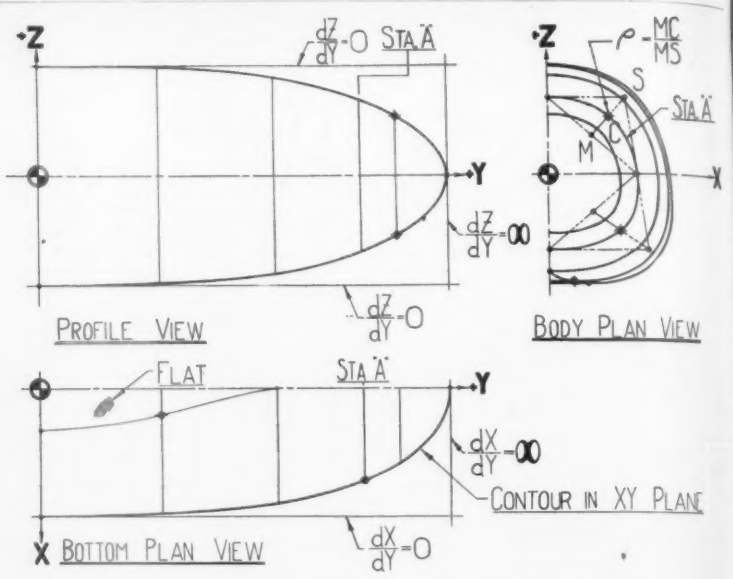


Fig. 4. Contour development of fuselage nose—algebraic and trigonometric system.

piece matching its slope with the next at the junction point. A refinement of this matching process would be to piece together curves by equating both slope and radius of curvature at the common point, obtaining a composite curve whose radius of curvature has no abrupt change. This matter of curvature continuity is not merely an unnecessary nicety but is something which can be detected physically as an additional improvement over slope continuity. For example, a configuration of a straight-line tangent to a circular arc is continuous as to slope but not continuous with respect to curvature, and a batten cannot be made to assume such a shape. This same line-circle shape is frequently designed into structural parts—hat sections, for example—but, when the finished product is closely examined, the elastic material is found to have only approximated the designed shape with a physically smoother curve. Similarly, longerons restrained at frame points assume a natural deflection curve probably differing from the designed external shape of the structure. Discontinuity of curvature is also easily visible in optical reflections and shadow lines. A discussion of the importance of curvature continuity may be found in

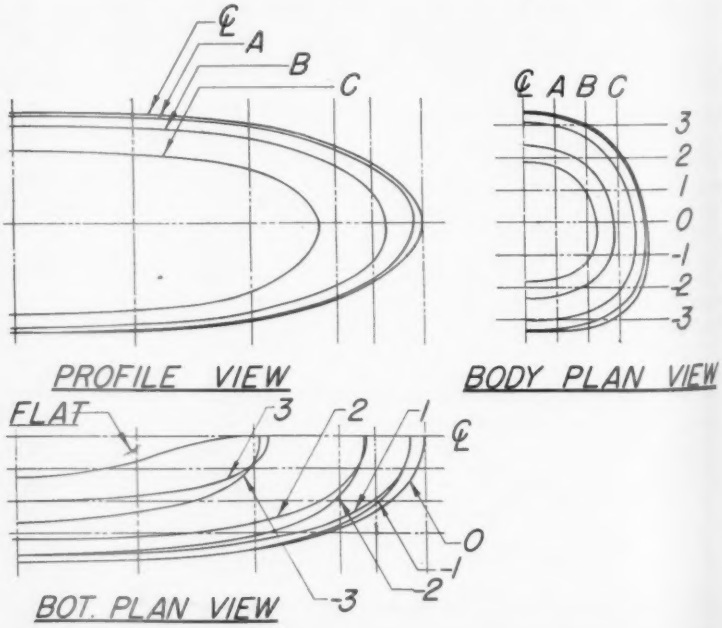
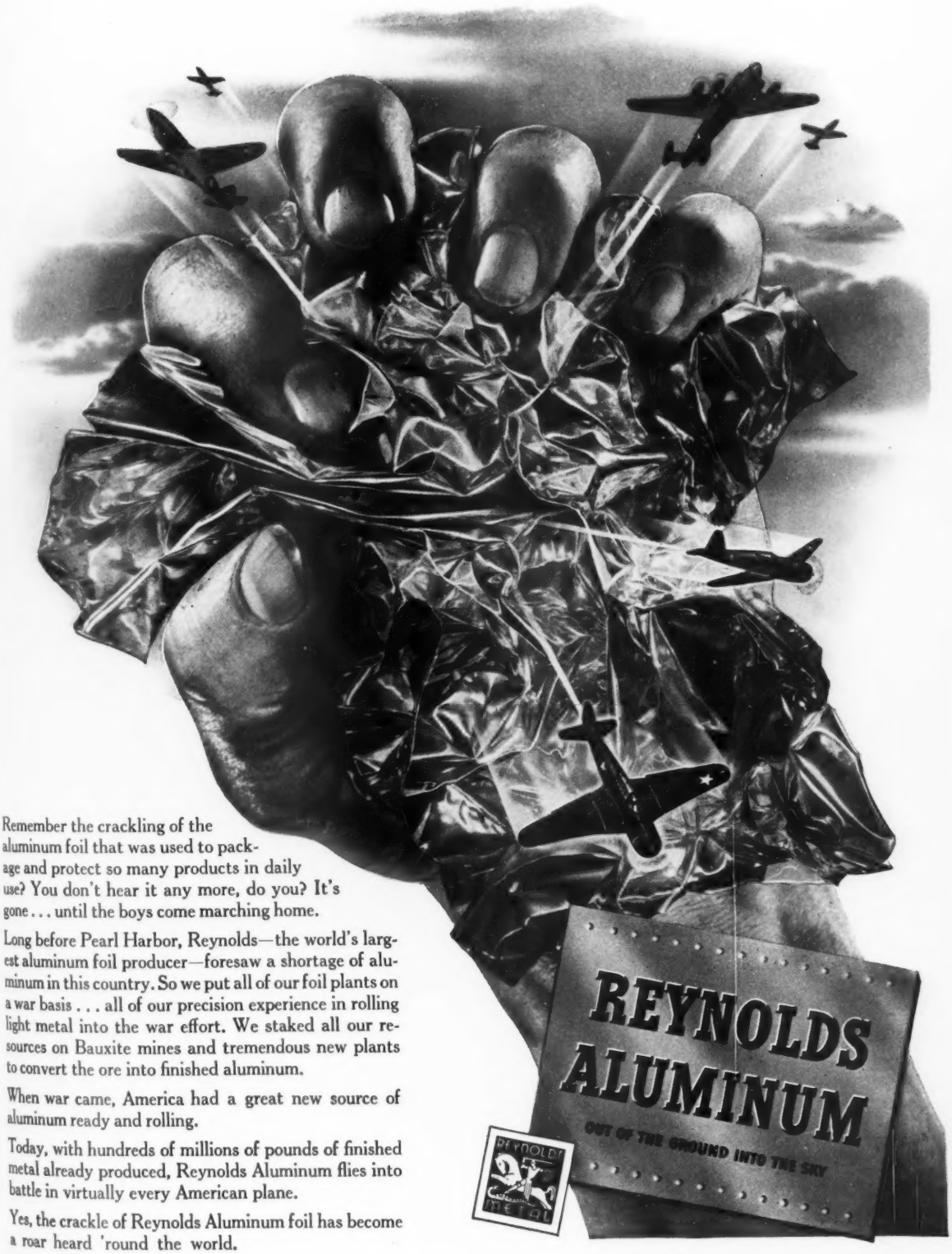


Fig. 5. Contour development of fuselage nose—buttock and water-line system.

The Crackle that Grew to a Roar!



Remember the crackling of the aluminum foil that was used to package and protect so many products in daily use? You don't hear it any more, do you? It's gone . . . until the boys come marching home.

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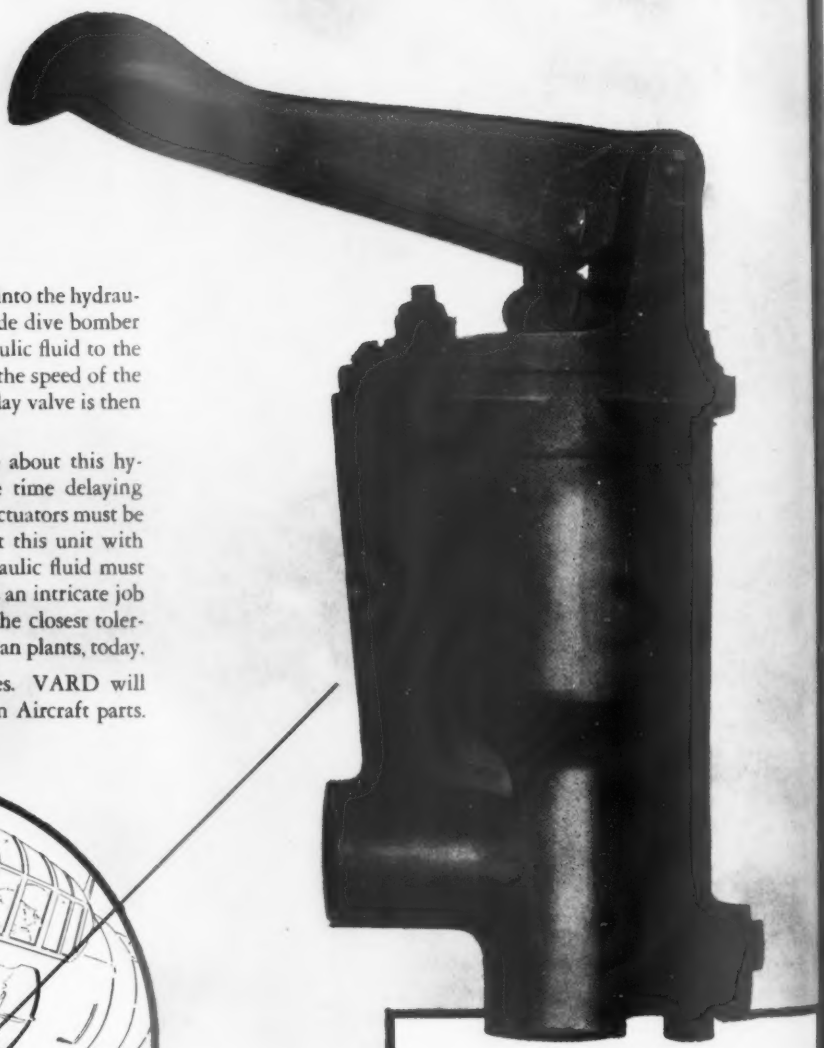

This Time Delay Valve fits into the hydraulic system of an American made dive bomber and controls the flow of hydraulic fluid to the wing flaps. These flaps brake the speed of the plane in descent. The time delay valve is then a brake control.

The distinguishing feature about this hydraulic unit is of course the time delaying element. Ordinary hydraulic actuators must be precision made, certainly, but this unit with measured control of the hydraulic fluid must be precision plus. In fact, it is an intricate job of machining right down to the closest tolerances being worked in American plants, today.

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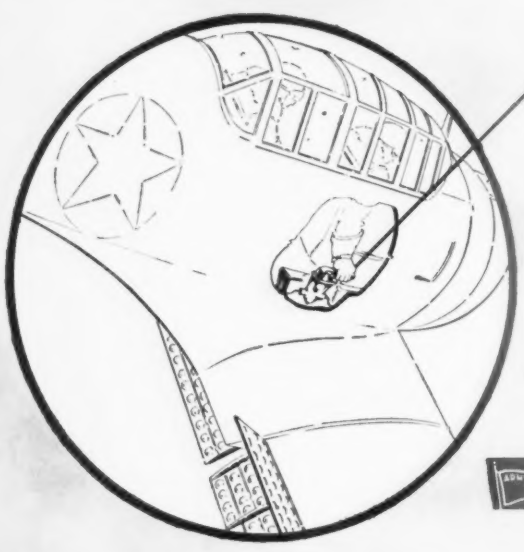

In times of Peace—Prepare for War. In time of War Prepare for Peace! All Americans must realize that war industries with depleted reserves, sinking funds and profits, can never rally to meet the Crash of Cancelled Contracts. We must have reserves to meet the storm—and Win the Peace.

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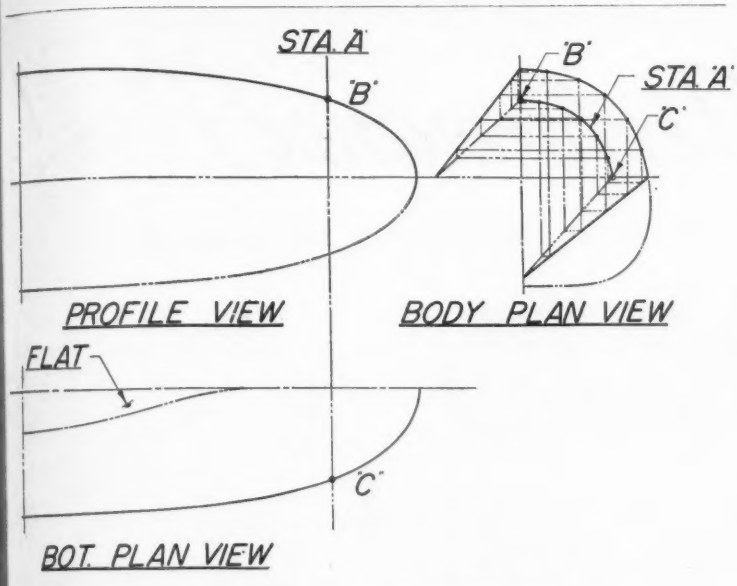

FIG. 6. Contour development of fuselage nose—key system.

the article "On the Geometry of Streamlining" by Max M. Munk.[1]

The type of function which may be used for curves to be fitted together with curvature continuity is necessarily more complicated than the simple second-degree functions (conics) that are frequently used when only slopes are matched at the common point of contiguous curve pieces. One evident possibility can be found in beam equations, classed mathematically as polynomials or power series:

$$F(x) = a_0 + a_1x + a_2x^2 + a_3x^3 + \ldots a_nx^n$$

A polynomial is then the equation of a curve complex enough to fit a complex set of conditions. An equation may be set up, for example, for an elevator nose shape, holding a given radius of curvature at the leading edge, having a certain fullness and becoming tangent to a straight trailing edge line with infinite radius of curvature. The five allowable conditions that determine a conic become, for a power series, n conditions, where n is theoretically unlimited.

The fact that a function is of high degree expands the range of utility of a function but at the same time, unfortunately, creates two general difficulties. One, of course, is the more complicated numerical work necessary in calculations. The other is that the functions have more freedom to misbehave; that is, a curve may hold each control point, slope, and curvature imposed on it but may do curious things between those points. For this reason a power curve should be only of a degree high enough to fulfill the conditions imposed on it. This still does not always assure the good behavior of the curve. Equations of this type should always be examined for peculiarities in the interval used.

A safer method of obtaining such functions is to use only equations that have previously been studied and found to be well behaved in definite regions and over certain ranges of the defining conditions. The number of such tailor-made curves is practically unlimited. A number of them have been produced and studied, each having certain qualities of slope and curvature. A normal or unit equation of this sort can then be graphed and distorted mathematically or graphically to fit into the position it must occupy. A typical example of a unit power curve is shown in Fig. 7. The equations for the curve show a surprising but not unusual simplicity. There appears one parameter a_0—directly related to the radius of curvature at one end, of which everything else is a linear function—coefficients, offsets and slopes at given intervals, even the area. This unit curve then may be stretched to the desired size, pushed into an oblique reference system, and fitted to another power curve, at the same time maintaining all of its inherent characteristics. If the resulting shape is not quite satisfactory, other basic curves may be chosen. The only difficulties lie in making the choice, and experience continually decreases those.

APPLICATIONS

It is evident that the mathematical material available for use in surface development is unlimited. Equations may be found to satisfy any given set of conditions. Curves may be distorted graphically and mathematically by means of any of the limitless number of transformations available. Projective transformations are used frequently. All types of linear transformation find application; on occasion, even quadratic transformations may be useful. Least square methods have been applied. Trigonometric functions are sometimes convenient.

A mathematical surface need not even be described as a function but can be a manifold of points; then the entire calculus of differences is available for use. Skin layouts, hull plate flat patterns, geodesics, areas, and volumes in such a system are only a matter of tabulation.

The mathematical approach is one that may be adopted gradually. A first attempt may go only as far as mathematical control lines or key lines, with the rest of the shape development following standard lofting methods; or a mathematical treatment may be introduced in a region where a knowledge of the final shape is desired at an early stage in design—for example, so that extrusions or spar caps may be ordered before lofting begins. Perhaps a determinate contour is chosen so that pressure distribution calculations may be made and relative aerodynamic characteristics predicted.

But the true worth of mathematical shapes becomes evident only when the entire structure is mathematical. Then, for the first time, the configuration is really a known quantity and, being known, can be worked with just as easily as if the prototype assembly were completed.

REFERENCE

[1] *Theodore von Kármán Anniversary Volume*, pp. 8–20, 1941.

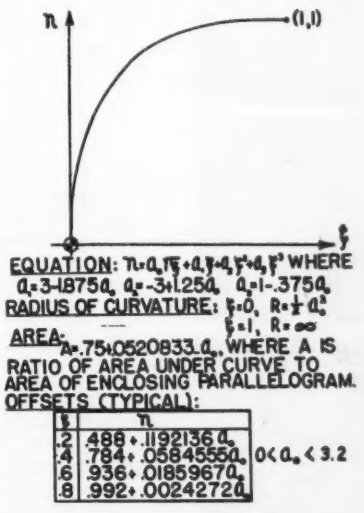

FIG. 7. Typical example of a unit power curve.

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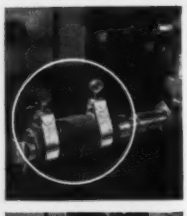

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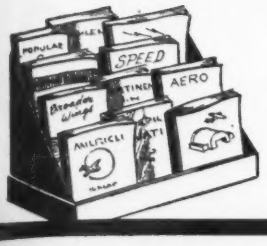

Periodicals

Accessories

High Output Generating Systems. W. F. Fell. Increasing demands for electric power in aircraft have brought problems for the builders of generators. Limitations of size and weight for the main engine-driven generators necessitated higher generator speeds with reference to the crankshaft speeds in order to get greater capacity but in large long-range airplanes, fuel economy dictates the operation of engines at slower revolutions per minute, aggravating the problems of electric power supply. Auxiliary electric plants were developed to take care of the need for an independent power source in case one or more of the main engines should not be functioning.

Generators of sufficient capacity to meet these conditions are described, with details of the innovations that have been incorporated in the design. Information is given on the carbon pile voltage regulator that was evolved, as well as the equipment required for the installation and operation of the system. Suggestions for the improvement of engine-driven accessories are made. It is stated that future generator designs of increased capacity will be based on the use of a power take-off with an accessory gear box driven from the main aircraft engine. *Aviation*, June, 1943, pages 167, 169, 170, 330, 331, 6 illus.

Aircraft Accessory System. Lt. Col. T. B. Holliday. This article deals with aircraft equipment not essential to flight but added to make the airplane easier to handle and safer to operate. Methods of obtaining power to drive the accessories are discussed and compared. It is stated that direct mechanical take-off from the engine is simple and efficient but has restricted use because of space limitations in the rear of the engine where the unit must be located. The hydraulic system has a lighter fixed weight than electrical units but possesses certain disadvantages, such as high loss in efficiency in cold weather. Pneumatic systems are held to be not satisfactory because of a definite control lag. The chief disadvantage of the electrical system is that of excessive weight, but it is stated that this is being rapidly overcome.

In the matter of transmission the electrical system is far more efficient than the hydraulic system, and this advantage becomes even more apparent as the length of the transmission lines increases.

Voltage and its hydraulic counterpart—pressure—must also be considered. A standard of 24 volts is now being used, a figure that can be increased almost without limit, whereas hydraulic pressures already seem to be approaching their upper limits. *S.A.E. Journal*, July, 1943, pages 234–240, 247 (Transactions), 18 illus.

Unlimited Revolutions for Gun Turrets. The power transmission unit that makes possible the continuous revolving motion of American aircraft gun turrets is analyzed. It has two major parts: a stator permanently attached to the main body of the plane and a rotor permanently attached to the turret. The electrical circuits are described, and information on the materials and processes used in making various parts of the unit from plastics is given. *Modern Plastics*, June, 1943, pages 85–87, 5 illus.

Aerodynamics

Aerodynamic Considerations of Rotors in Hovering and Vertical Climb Conditions. Charles H. Kaman. This article deals with the application of the results of S. Goldstein to analyses of direct lift rotors in the particular conditions of "hovering flight" and "vertical climb." It is felt that Goldstein's vortex theory will offer definite improvements in particular types of rotor calculations and will, as a part thereof, show more clearly the relative effects of different number of blades and point the way to optimum aerodynamic design criteria. The theory has been discussed briefly and the principal equations applied.

A working system based on the theory has been set up enabling rapid elemental analyses of rotors in the named conditions. As a practical illustration a study has been prepared showing the optimum distribution of the parameter $(b/D)C_L$ for 2-, 3-, 4-, and 6-bladed rotors operating at or near hovering flight. The results show that the tapered and twisted blade is desirable and that the load distribution shifts slightly toward the tip with an increasing number of blades.

A simplified system in the form of a representative station method has been included for those types of analyses where comparative performance of the principal variables is to be studied. The method is flexible and easily adaptable to a solution of any of the major variables such as diameter, hp., r.p.m., blade characteristics, etc.

It is urged that research programs be initiated for the purposes of verifying the theory and permitting empirical extensions into those analyses

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that at present involve prohibitive computations. *Journal of the Aeronautical Sciences*, July, 1943, pages 201–208, 16 illus.

Regions of Infinite Acceleration and Flow Realms in a Compressible Fluid. Max G. Scherberg. When a body moves in a compressible fluid at speeds comparable to the speed of sound in the fluid, then there will exist, in general, regions of fluid near the body in which the speed relative to the body is supersonic. Experience in the wind tunnel and in flight has shown that such flows are usually accompanied by shock waves, as a result of which there is, among other things, a large increase of drag coefficient. Since shock waves are being associated with the presence of flow conditions, which call for regions of infinite acceleration, it becomes important to determine the circumstances under which such regions are present and to seek methods of avoiding these conditions. *Journal of the Aeronautical Sciences*, July, 1943, pages 223–226, 5 illus.

Streamlining Dynamic Stability Computations. Part II. Max M. Munk. The second of a series of four articles on the computation of dynamic stability indicates that the central mathematical operation is the solution of a biquadratic equation with one unknown quantity. The problem is stated and the equation is set up. The cubic resolvent and its reduction are explained, and the solutions of the reduced resolvent are presented for three real roots and one real root. A graphic solution of the reduced cubic resolvent is said to have advantages in the simplification of some of the calculations. A discussion of the improvement of the root and the determination of the imaginary portion of the root concludes the current part of the series. *Aero Digest*, June, 1943, pages 183, 185, 327, 1 illus.

Air Cargo

Packaging and Handling of Air Cargo. C. G. Peterson. The experience of the Railway Express Agency in handling air cargo is summarized and comments are made on the classes of commodities and merchandise moved by air. The relation of air cargo costs to volume of tonnage carried is discussed, and the importance of keeping loading and unloading time down to a minimum is emphasized. It is stated that the rate of increase in air express is keeping pace with the rate of increase in passenger-miles. Special commodity rates, canceled for the duration, have helped develop tonnage. Machinery, tools, and parts are cited as the top group and represent about one-third of the total air express in one particular month. Off-air-line business will result in the increased use of pickup equipment.

Great future possibilities are seen in the utilization of the more than 300,000,000 ton-miles of unused capacity of passenger plane routes, which figure is more than 60 times the volume of air express and freight flown in 1941. Spreading direct flying costs over the combined passenger and freight plane capacity in aircraft designed for the task is fundamental in lowering ton-mile costs for the postwar period. Handling costs are discussed, and how the use of magnesium roller conveyers is saving loading time in 200 of the company's terminals is described. The use of portable elevators, trucks with elevated bodies, and inclined conveyers of the continuous flow type as means of saving loading time is also included. *S.A.E. Journal*, June, 1943, pages 210–219 (Transactions).

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Will My Product Be Suitable for Shipment by Plane? George F. Bauer. It is emphasized that when approaching the subject of air transport the business man should remember that time is money. He should analyze the different steps in typical transactions of his trade from the angle of what effect a possible saving of four-fifths of normal time may have on each of them if air cargo is used in world commerce on an extensive scale after the war. The writer states that it is only through a study of all the ramifications of a trade that the time-saving benefits can be translated into dollars and cents and the real scope of air cargo determined for a particular business. *Air Transportation*, June, 1943, pages 38, 39, 41, 1 illus.

Air Power

Air Power Now Assumes Dominant War Role. Leslie V. Spencer. An analysis of the role played by air power in recent war events. Indicating the air superiority that is being achieved by the Allies' mounting aircraft production, the writer claims that air action on the European and African fronts is proving the efficacy of aerial attack for softening an objective to the point where ground troops can capture it with a minimum loss of life and equipment. He discusses various techniques of air fighting which have been evolved. These include: the leveling of industrial or strategic communities by great numbers of bombers, as demonstrated over Germany; the employment of successive waves of bombers to open a corridor through which troops and ground equipment can proceed, as used in the Tunisian campaign; and constant, scientific bombardment of a military objective to obtain its capitulation, as was accomplished in the case of Pantelleria. The extension of such techniques to the Pacific is noted, and figures are quoted on the ratio of loss suffered by the Axis and the Allies on both fronts. *Aero Digest*, June, 1943, pages 111–115, 12 illus.

Air Transport

Air Freight, Unlimited. David Baker. This article explains how the building of two large Canadian dams was made possible through the employment of all-air transportation for construction equipment, supplies, personnel, and animals to otherwise inaccessible sites. Naming the aircraft that were used for the job (including a Ju 52), the writer indicates the importance of medium-sized planes in making year-round operations possible under subarctic conditions. The job concerned was the Shipsaw waterpower project for the Aluminum Company of Canada.

Problems of time, terrain, and weather are noted and details are given on the amounts of tonnage hauled, the equipment and methods used, and the type of specialized flying that was necessary. Winter operations involved flying with skiis; summer operations, flying with floats. *Aviation*, June, 1943, pages 114–117, 335, 337, 13 illus.

Air Transports—Past and Future. W. W. Davies. The past development of the airplane is reviewed and possible future developments in aircraft and their operation are discussed. Major design features of some of the heavier-than-air craft developed and used for flight since the early days of the Wright brothers are set forth. Trends in aircraft performance and design are traced, and advances in engine and propeller design are outlined. Charts show the trend in the gross weight of aircraft, useful load ratio, wing loading, power loading, maximum speed, cruising speed, maximum range, take-off distance, horsepower, engine weight, and airway facilities.

Past and future commercial aircraft operations are discussed. A typical trip analysis is presented for 1930, for 1941, and for the postwar future. A table shows the general characteristics of possible postwar airplane types for transcontinental service. Four types are listed and a typical trip analysis for each type is made. Other charts show the block-to-block speed, elapsed time, direct flying cost, and delays

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and forced landings. *Mechanical Engineering*, July, 1943, pages 471–485, 25 illus.

Our Gigantic Global Air Transport Services. A survey of the U.S. Army and Navy air transport services. This article outlines the functions of the Army Air Forces Air Transport Command and the Naval Air Transport Service. It is concerned with their organization, routes, covered mileage, equipment, and personnel. The development of global air transportation under wartime pressure is noted, and the diversified cargoes that are carried by air to and from the United States are described. The article also mentions that present-day air cargo transportation does not attain maximum efficiency because the planes in use are designed for general all-around utility rather than specifically for cargo purposes along a particular route. *Aero Digest*, June, 1943, pages 118–121, 342–344, 11 illus.

Airline Gains Impressive Despite 50% Equipment Cut. The operating record of America's domestic air lines for the year 1942 is reviewed, it being noted that impressive gains were scored in all operating categories despite a reduction of 50 per cent in the number of aircraft available for use. Express showed the most significant increase in tons carried and in ton-miles flown. Figures are taken from a study of eight years of domestic air carrier operations recently completed by the Civil Aeronautics Authority and are given in chart form covering such factors as express tons carried, express and mail ton-miles flown, revenue passengers, passenger-miles, passenger load factor, number of planes in service, average number of seats per plane, and revenue-miles flown. These statistics are analyzed, and the opinion is expressed that the trend will not go into a serious decline when emergency shipments cease. *Aviation*, June, 1943, pages 211, 356, 10 illus.

International Operation to Be Complex. E. J. Foley. International air transport operation is discussed, particular attention being given to problems of supply, maintenance, and personnel. Maintenance of suitable stocks at each line station is advocated. It is suggested that there may be economic justification for the long-range operator to maintain a small fleet of cargo aircraft for interstation liaison of materials and men. With international lines the simplicity of intranational operations must be forgotten. National boundaries, duties, customs bonding, clearance, and other similar elements become vital adjuncts to the supply process. *American Aviation*, June 15, 1943, pages 58, 71, 72, 1 illus.

Feeder Line for the West. James G. Ray. The vice-president of Southwest Airways urges immediate action by the Civil Aeronautics Board on applications made by his company and others for permanent franchises to operate feeder air-line services in the states of Washington, Oregon, and California. Reporting that similar feeder lines have been operated by Southwest for the Army Air Forces, he outlines the system proposed by the company for Pacific Coast civilian air transport. Figures are submitted on the mileage planned, the cities that will be served, the number of daily flights, etc. In addition to emphasizing the need for feeder air-line services, the writer also presents answers to the following questions: Are feeder lines successful? Will feeder air lines carry only mail and cargo, or will they also transport passengers from smaller cities to the main air-line terminals? Are pickup and feeder air lines as safe and dependable as the present trans-

Center panel-main rib installation fixture used in production of the Curtiss (C-46) Commando troop transport.

continental systems? *Western Flying*, June, 1943, pages 46, 47, 104, 3 illus.

Fixed-Base Operation Has Bright Future. E. J. Foley. Some ideas suggested for the consideration of fixed-based air-line operators are examined. Certain functions that appear appropriate to the fixed-base operator after the war are discussed. Subjects covered include the handling and sale of fuel and oil to private owners operating out of a particular base, the development of a housing project as an integral part of the airport project, repair facilities that the small operator can make available to the private operator, and sales offices and showrooms. *American Aviation*, July 1, 1943, page 64, 1 illus.

Air Cargo Tomorrow as the Government Sees it. The report of the Office of War Information covering the various phases of American air transport is reproduced in full in a two-part article. Seven points brought out by the report are summarized in an editorial introduction to the text of the report. Numerous photographs of current types of American aircraft are accompanied by lengthy captions giving certain specifications and other information. The first part of the article covers those sections of the report on American transport planes, air lines and civilian flying, three all-cargo services, the Army Air Transport Command, Naval Air Transport Service, and the future of air transport. The second part will include the remainder of the report, covering the work of the Civil Aeronautics Board and Civil Aeronautics Administration, airways development, and pilot training, as well as other cargo aircraft. *Air Transportation*, June, 1943, pages 10–16, 18–20, 22–30, 12 illus.

Airplane Descriptions

Typhoon. The evolution of the Hawker Typhoon is traced by showing a series of illustrations beginning with the Sopwith types through the early Hawker types of 1923–1929, the Furies, the Hurricane, the Typhoon 1, to the Typhoon 1B. The span, length, height, loaded weight, maximum speed and engine of each model are listed. *The Aeroplane*, May 14, 1943, pages 559–561, 27 illus.; "Hawker's Latest Fighter," *Flight*, May 13, 1943, pages 492–494, 10 illus.; "The Typhoon," Alexis Dawydoff, *Air Trails*, July, 1943, pages 26, 27, 5 illus.; "The Hawker Typhoon," *Automotive and Aviation Industries*, June 15, 1943, pages 41, 90, 2 illus.

New Nazi Planes. A brief description is given of the Blohm and Voss BV-222, six-engined flying boat, one of which was shot down over the sea between Tunisia and Italy. The dimensions are given and it is stated that the engines are the BMW-132 D.C., of 1,000 hp. each.

Several other new German types are described, including the Henschel 120, which is smaller in dimensions than its predecessor bearing the same designation. Other differences between the new plane and its prototype are indicated, including information on its two 650-hp. Gnome Rhone 14 M radial engines instead of the two 450-hp. air-cooled in-line Argus engines used in the predecessor. Available information is summarized on the engines used with the various other operational types of German aircraft. *Air News*, June, 1943, page 22, 1 illus.

The New Luftwaffe. James L. H. Peck. A description is given of new designs of German aircraft and modified old designs that are credited with enabling the dwindling Luftwaffe to continue fighting. It is stated that the most outstanding plane is the Messerschmitt Me 109 G-2 fighter bomber, which is reported to be in larger scale production than any other fighter. Powered with a 1,500-hp. Daimler-Benz engine, this single-seater has a top speed of 395 m.p.h. at 22,000 ft. and a ceiling of almost 40,000 ft. This plane, along with the Messerschmitt Me 109G and the Focke-Wulf FW 190A-3 has been in service for some time in Tunisia and over Germany. The new Focke-Wulf FW 290 and the Messerschmitt Me 210 have been reported active recently in both theaters of the war.

The FW 290 is a slightly larger version of the FW 190, powered with a 2,100-hp. BWM twin-row radial engine having 18 cylinders. It carries the same four-cannon, two-gun armament combination, but the ammunition load of each gun is doubled, giving the plane considerably greater staying power. The new Messerschmitt is a two-seater fighter and is used as a dive bomber or attack bomber. It is powered with two 1,270-hp. Daimler-Benz engines that afford a top speed of 370 m.p.h. at 18,000 ft. and a 30,000 ft. ceiling.

Other planes that are still in production are enumerated. It is explained that the largest of Germany's new tactical types of aircraft are the six-engined Blohm & Voss BV-222 flying boat and the Messerschmitt Me 323 troop carrier, which is said to have been developed from a large glider. A recent liaison plane is the Messerschmitt 208, featuring the first known German tricycle landing gear. *Air Trails*, July, 1943, pages 19–23, 20 illus.

Representative Aeroplanes of the Regia Aeronautica. Specifications are tabulated for current types of Italian airplanes, accompanied by three-view silhouettes of several of the important makes. Under the headings of name, power unit, dimensions, and maximum speed, the following classes of aircraft are included: fighters, attack bombers, light bombers, medium bombers, heavy bombers, bomber transports, transports, army cooperation biplanes, civil floatplanes, military floatplanes, civil flying boats, military flying boats, and experimental aircraft. *The Aeroplane Spotter*, May 20, 1943, pages 114, 115, 17 illus.

Airports

Air-Borne Front Line Hangar. W. B. Larkin. The construction and erection of a hangar for front-line service are described in detail. Designed for transportation by air, complete with necessary equipment to erect it or dismantle it in a few hours with unskilled labor, the structure consists of components that are light in weight and capable of being packed in uniform packages. The tied, three-hinged arch design with transverse bents is said to provide a statically determinate structure that can be erected on fairly irregular terrain. Strip steel, cold-formed by rolls into engineered shapes, is used for the majority of structural members, and flame-proofed canvas, suspended beneath the steel structure, is used for the covering material. *Aero Digest*, June, 1943, pages 245, 330, 331, 3 illus.

World's Greatest Airport to Serve Skyways of Tomorrow. Jack O'Brine. New York City's new 2,576-acre municipal airport is now under construction. It is predicted that scheduled flights that begin or end at the new terminal will reach 950 daily. The new airport will have 13 miles of concrete runways for landplanes and three large landing areas in Jamaica Bay for seaplanes. Portable control towers are planned as auxiliaries to the main control tower to overcome the vision difficulties caused by the size of the field. *Popular Science*, August, 1943, pages 74–77, 6 illus.

Goose Airport. Pilot Officer W. A. Shields. A description of Goose airport, which is located in a bleak part of Labrador, far to the north of normal peacetime transatlantic flight routes. Information is given on how this strategic development, which is stated to have cost approximately $15,000,000, was built, and the way it is being operated by Canadians.

It is stated that Goose airport is one of the busiest airdromes on this side of the Atlantic and that in one crowded 24-hour period it serviced more than 100 aircraft, fed the crews, and sent them on their way to Europe. The R.C.A.F., the R.A.F. Ferry Command, and the U.S. Army Air Transport Service share the facilities of this airport. According to the commanding officer of the United States section, the United States air transport unit alone has arranged to accommodate in 1943 double the number of planes which passed through in 1942. *Cana-*

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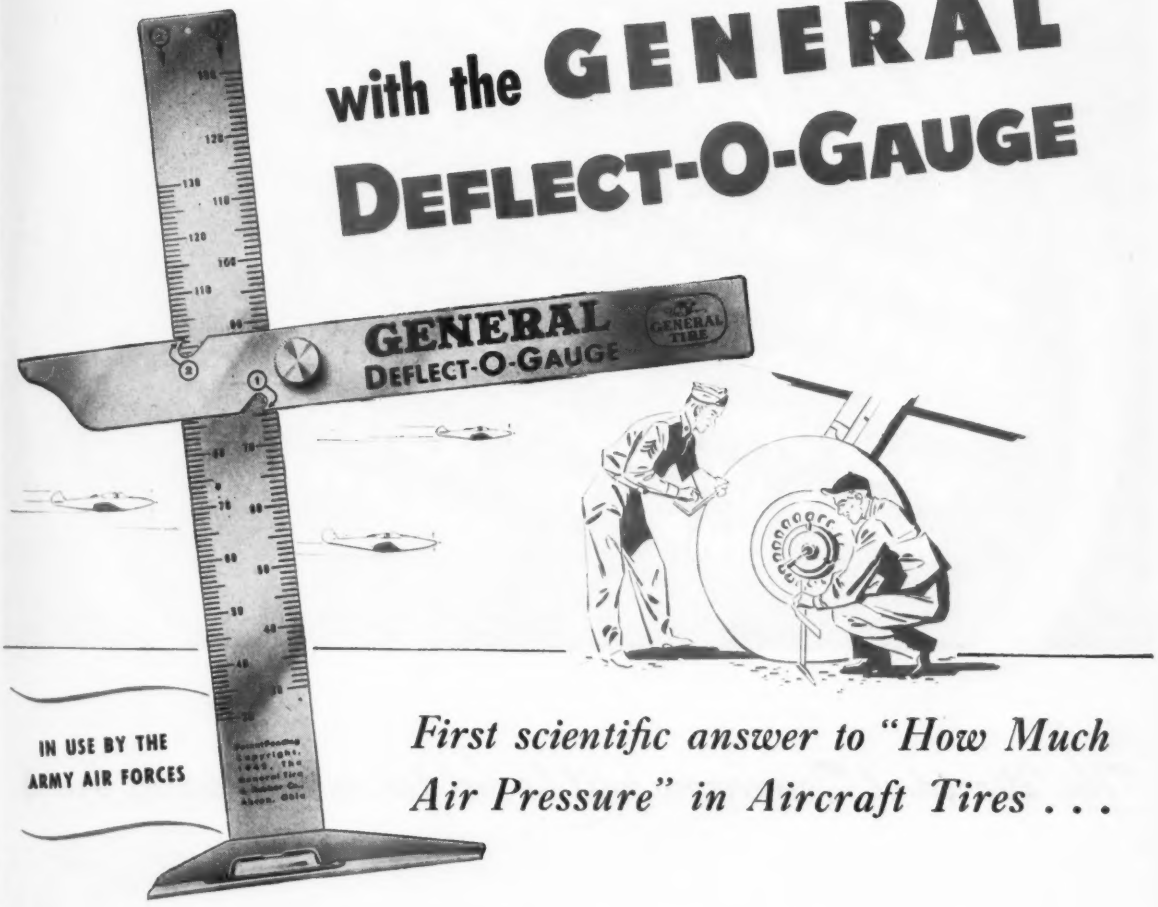

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dian *Aviation*, June, 1943, pages 87–90, 117, 118, 8 illus.

Post-War Air Terminal. Hans J. Lubig. The writer submits a design for a major air terminal that would accommodate the expected growth in postwar commercial air transport. This layout calls for the air terminal building to be set in the center of the field with an underpass leading to the building. Designed to fulfill a need for 280 take-offs or landings per hour, its traffic pattern is based on two runways to the left of the building and two to the right.

The article also points out the importance of cooperation between the Federal and city governments in planning airport facilities that would not only take care of present military needs but would also be adaptable to postwar requirements. Reasons are listed why present airport construction by the Air Forces cannot be expected adequately to fulfill commercial requirements after the war. *Flying*, July, 1943, pages 60, 61, 160, 4 illus.

Armament

. . . Has Aviation Doomed the Tank? William Levenor. A discussion of the value of aircraft as antitank weapons. The writer's conclusion is that antitank aircraft, together with tank-destroying self-propelled artillery, are responsible for a decline in the tank's decisive importance. Making a corollary statement that concentrated fire power has always overcome defense, he traces the evolution of airplane armament and analyses its tactical advantages against tanks. Some variations in aircraft-gun types and sizes are reviewed, as well as some design problems involved in mounting large guns on aircraft. Mention is made of the gun installations on the Airacobra, Boston, Lightning, Hurricane IID, and Stormavik. *Flying*, July, 1943, pages 21–23, 128, 130, 6 illus.

Naval Armament. Rear Adm. W. H. P. Blandy. An article on the sea and air weapons of the Navy. With regard to naval aircraft weapons, it is explained that to sink a battleship it is necessary to use armor-piercing bombs because the modern battleship has a protective deck about $^1/_2$ ft. thick and the tops of its gun turrets are equally thick. The usual demolition bomb is insufficient for the purpose. The bomb shell must be especially designed for the job. The principal requirements are a delayed-action fuse, a thick wall and heavy nose, and, consequently, a small bursting charge. Sufficient striking velocity can be obtained only by dropping the bomb from high altitude or by diving at extremely high speed. In either case, accuracy is difficult to achieve. To bomb a ship accurately in horizontal flight requires a precision bombsight. It is stated that the Norden bombsight is the finest sight of this type known. The best method of attacking well-armed ships at short range is by dive bombing.

The Bell Aircraft Corporation's machine-gun adapter ready for installation on a 0.50-caliber machine gun. This improves the accuracy of fire by dissipating the heavy recoil forces. (See page 170.)

The advantage of the torpedo is emphasized and its functions are explained. The torpedo, while the deadliest weapon of the sea, is the most difficult to make, maintain, and adjust. The increased range of usefulness of the antisubmarine depth bomb now that it can be dropped from the air is pointed out. The writer proceeds with a discussion of the weapons of surface ships and concludes with information on antiaircraft guns. Numerous anecdotes on the accomplishments of these guns and their crews are related. It is emphasized that full advantage is taken of experience gained in battle, in the planning of air and sea weapons. *Army Ordnance*, July-August, 1943, pages 81–86, 3 illus.

The Norden Bombsight. Kurt Rand. This article contains a few details on the operation of the Norden bombsight which have been released by the Navy. It also explains why, although the Germans undoubtedly have examined some of the bombsights by this time, the knowledge is unlikely to be of great use to them. One reason given is that the Norden bombsight involves a bombardier-training technique, wholly different from that of Germany's, which cannot be inaugurated at this stage of the war. Other reasons are the multiplicity of small parts required for the bombsight, the extremely fine tolerances to which they must be machined, and the scarcity of essential raw materials in Germany. Notes are included on the formation, history, and management of Carl L. Norden, Inc., sole manufacturers of the device. *Flying*, July, 1943, pages 37, 38, 148, 3 illus.; "What Makes Our Bombsight So Deadly?" *Popular Science*, August, 1943, pages 92, 93, 3 illus.

Avigation

Great Circle Tracking. Tappan Collins. The recommended plan of air navigation is defined as a method for making it convenient for the navigator to deal with flight as motion that follows a selected great circle imperfectly, with his normal task reduced to measuring the run and correcting imperfections in the tracking. This is likened to what the pilot does at present when following the beam of the radio-range system. In this article celestial navigation is handled in that way, with a method for reckoning fix directly in terms of off-course error and distance out from the point of departure. The computation form used is explained at length, and an example is worked out through the laying of a course from San Francisco to Sydney. Detailed instructions are given for determining the position and direction by the use of certain stars. It is stated that the method can be applied to any great-circle route anywhere on the earth. *Aero Digest*, June, 1943, pages 122–124, 139, 319, 336–339, 6 illus.

Business and Finance

. . . And Just Where Are Those Profits? H. L. Federman. An analysis of the aircraft industry's profits. The writer claims that the Securities and Exchange Commission's tabulations, compiled for "use in renegotiating contracts" are inadequate as a precise measurement of such profits because they are confined to earnings on invested capital and do not include consideration of average profit on sales. On the basis of the presented data showing the return on invested capital and ratio of net profit to net sales for a representative group of individual aircraft companies, he explains why he believes profit margins to be a more accurate gauge of aircraft earnings. To support his line of reasoning, he compares the Securities and Exchange Commission's report of "106 per cent average gross on invested capital" with that of a bank survey stating that the average war-product manufacturer's 1942 profit on sales after taxes was "but little more than 4 per cent."

The article also includes a discussion of the airplane industry's current financial planning for postwar developments. The Boeing Aircraft Company's 1942 annual report is exemplified as a demonstration of such plans. *Aviation*, June, 1943, pages 118, 327–329.

Aircraft Firms Study Other Fields for Postwar Output. Clifford Guest. A report by the chief of the industrial section of the National Resources Planning Board is quoted to show the plans that are being made by numerous aircraft companies in connection with their activities after the war. It is stated that the Board has made studies of the principal metals used by the aircraft industry, including magnesium, aluminum, and steel, with a view toward the application of the facilities of the aircraft companies to other lines of work if it should be necessary to supplement their present lines.

The plans and research work now undertaken by various companies are briefly reviewed. It is stated that Boeing Aircraft Company has set up a special research department and that

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Lockheed has investigated some 140 different products for possible post-war manufacture. Other fields that have been investigated by the aircraft companies are the possibilities of making washing machines, refrigerators, stoves, radio instruments, automobile bodies, metal furniture, and prefabricated houses. *American Aviation*, June 15, 1943, pages 25, 28.

Camouflage

Hints on Effective Camouflage. J. Duncan Campbell. The writer offers some general recommendations on the effective camouflage of industrial centers in the United States. After discussing the necessity for camouflage, its value, the tendency toward low-cost camouflage in this country, and the factors to be considered in determining whether a site should be camouflaged, he explains the fundamentals of what should be concealed and suggests several methods of doing it. Concentration of camoufleurs upon concealment of vital items within a general area—because the science of navigation makes it impossible to falsify the location of a general target area—is remarked. *Aero Digest*, June, 1943, pages 116, 117, 224, 327–330, 1 illus.

Civil Aviation

Paratroops of the Home Front. Ralph L. Hand. An article on the parachute jumpers who fight and control fires in the northern Rocky Mountains region of the United States. It is shown how great reductions in forest-fire damage have been effected by these men who—dropped from airplanes by parachutes, with fire-fighting equipment—are able to reach the spot where the fire has started more quickly than by any other means of travel. The article describes briefly the training received by the "smoke-jumpers," methods of parachute landing on rocky and difficult terrain, and the history of this phase of forestry. *Western Flying*, June, 1943, pages 48–50, 118, 3 illus.

You'll Still Fly a "Putt-Putt." William T. Piper. It is predicted that light planes rather than helicopters or roadable gyros will be used by those with a moderate income after the war. Some of these light planes may be of improved design with better streamlining, retractable landing gear, flaps, and more efficient engines, but they will still be of conventional design. That the helicopter has its advantages is admitted, but the opinion is that they may cost more to build and that pilots accustomed to fixed-wing airplanes will not feel at home with a large revolving "fan" overhead. It is conceded that the 400 m.p.h. plane is definitely here, but it is not for the average private owner because he cannot afford to buy or operate that kind of plane. *Air Trails*, July, 1943, pages 18, 61, 62, 2 illus.

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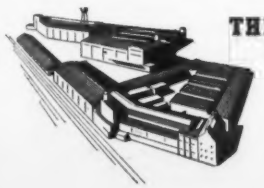

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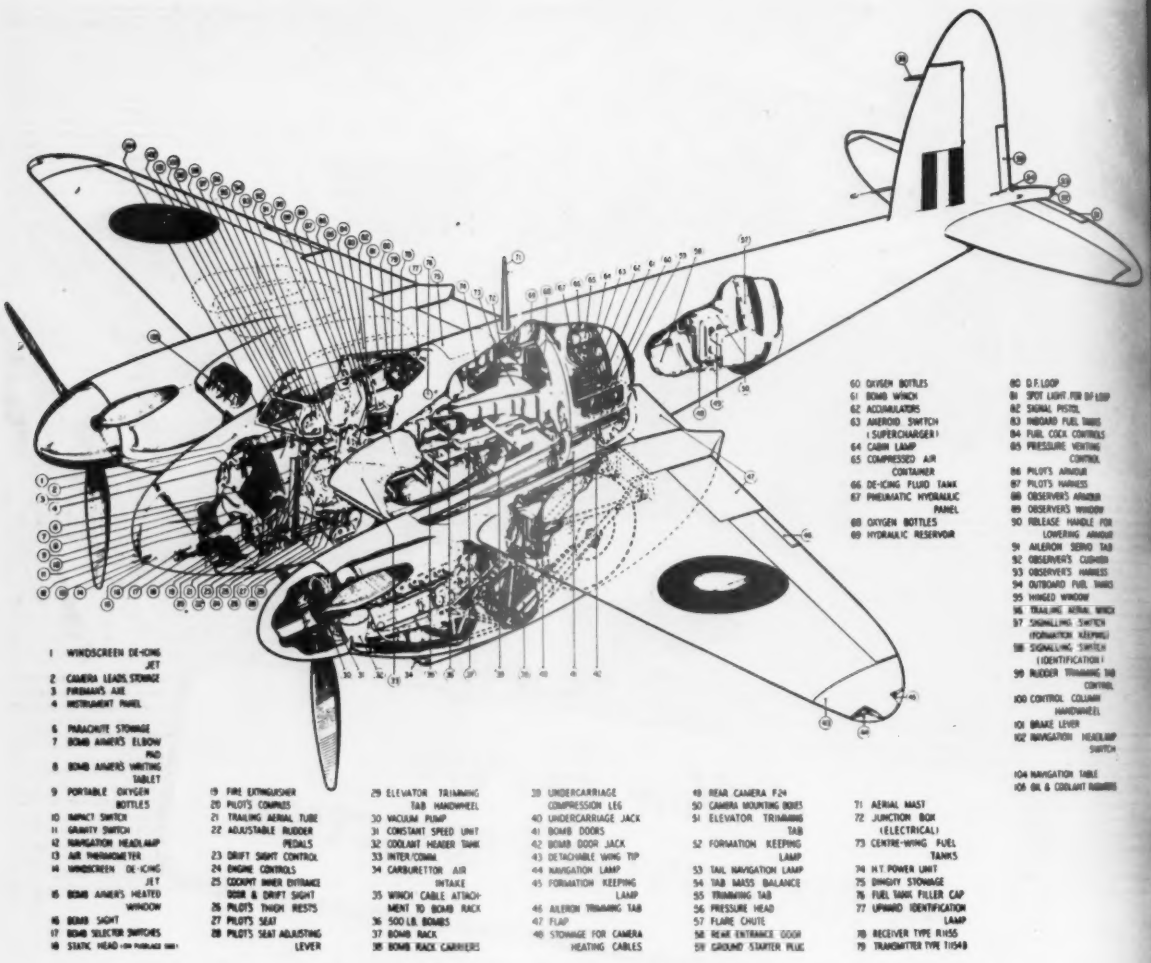

Details of the Mosquito IV plywood bomber. (See page 177.)

Design

Analytical Geometry in Common Layouts. S. J. Garvey and K. W. Hetzel. It is stated that the common method of "laying out" geometric problems on the drawing board leads to a large expenditure of man-hours and, in general to results of doubtful accuracy. This loss of accuracy is aggravated by scale, and results on large structures may be inaccurate by a prohibitive amount. The use of analytic geometry may be said to have two major advantages: (a) Less man-hours are required, and (b) any desired standard of accuracy may be obtained.

A solution is given for a common geometric problem—namely, the retraction of an undercarriage about a single axis. It is assumed that certain data are given, and other figures must be computed by the use of the theory, which is explained and demonstrated mathematically. Methods for determining the angle of retraction, the toe-in and the side rake of the axle, and the motion of any point on the chassis are worked out by equations. A numerical example is given. *Aircraft Engineering*, May, 1943, pages 132–134, 143, 3 illus.

Lofting Problems of Streamline Bodies. Part 14. Carter M. Hartley and Roy A. Liming. The fourteenth part of this study of lofting shows that the canted fuselage section may be calculated through a procedure based upon the mathematical description of the basic fuselage control curves without reference to the graphic layout. The procedure is based upon the familiar analytic technique of developing the equation of the plane of the required canted section, thereafter treating it as part of a simultaneous system of equations, the other equations of the system consisting of the quadratic equations describing the body-plan contours through which the plane of the canted section passes. The calculation of any type of canted section, whether a single cant in the side view or a single cant in the plan view or a double canted section, is fundamentally the same in each case as far as basic procedure is concerned.

The calculations for the single cant, side view and plan view, are then explained, followed by the application of the method to the double cant. The advantages of the application of such techniques to the development of canted fuselages are summarized. *Aero Digest*, pages 205, 207, 209, 321 324, 5 illus.

Engineering by Subtraction. Norman V. Davidson. It is explained that the sudden impact of war left insufficient time for the development of completely new airplane and aircraft component designs and that most of the work of designers has been a matter of adding to existing designs, taking what was available and changing or adding to it to accomplish the particular task that was pressing at the moment. The writer cites as examples the addition of protected fuel tanks, armor, and armament to the fundamental prewar airplanes, along with other adjuncts that have increased the bulk, weight, and contents of the craft. He explains how design compromises had to be accepted, with increasing complexities resulting from the process of adding to the airplane, and states that the time has come to undertake "engineering by subtraction."

Elimination of unneccessary parts and consolidation of function to accomplish more than a single purpose are urged, such as making the armor support itself and add to the strength of the airplane; finding a finish that

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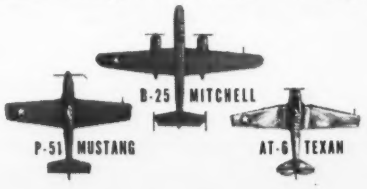

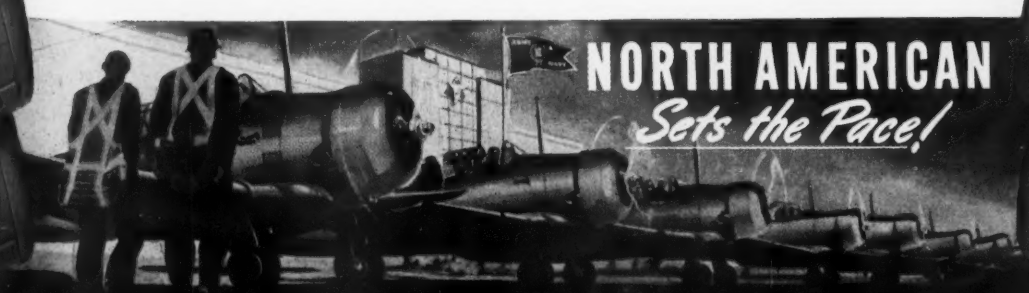

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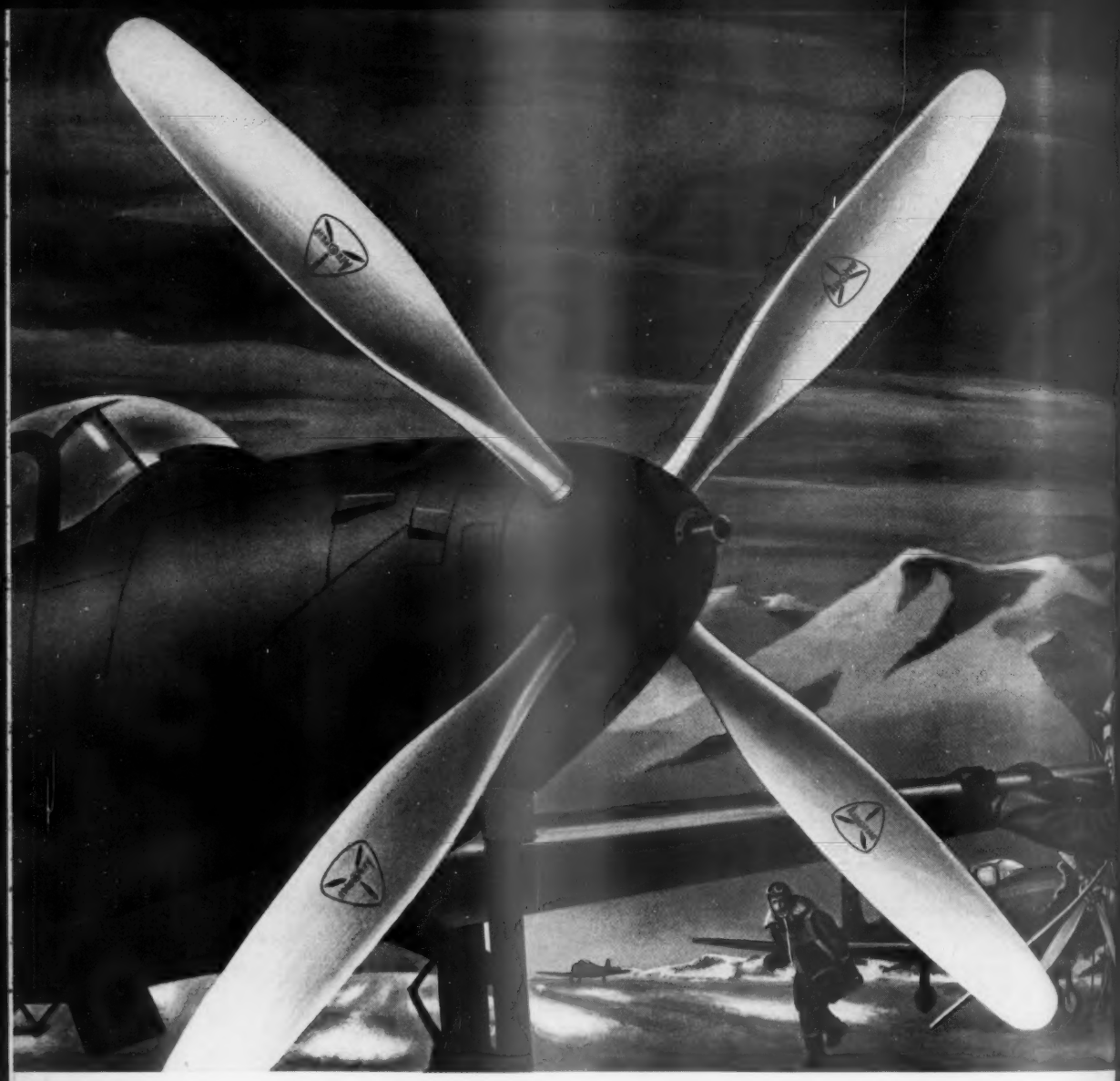

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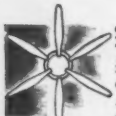

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will serve to prevent ice formation, thus eliminating the deicing equipment; combining functions of the radio antennas; simplifying aileron and tab design and control systems; and interchangeability of parts. *Aviation*, June, 1943, pages 165, 333, 334, 1 illus.

Turbines and the Flying Wing. G. Geoffrey Smith. Comments are made on the development of the flying wing design and on the suitability of this type of aircraft for propulsion systems different from systems using the radial or in-line internal-combustion engine. The history of the development of tailless airplanes is reviewed briefly, covering early British types and explaining the aerodynamic principles involved. The views of F. W. Caldwell of United Aircraft Corporation are given and the Northrop flying wing design is briefly described. Various power units suggested for these types of aircraft include gas turbines, jet propulsion, and flat-type engines, and their advantages and limitations are discussed. Other points considered are pressure cabins and landing gears. Suggestions are advanced for designs of large tailless aircraft and their power-plant arrangements, consisting of turbines or jet-propulsion units, reciprocating engines, or combinations of these. It is concluded that the way is open for the development of large transport aircraft along the lines mentioned, with gas turbines favored for smooth running and their adaptability for streamlining, while jet propulsion is rated superior for high altitude and high speed. *Flight*, May 13, 1943, pages 496–498, 2 illus.

North American P-51 Has Novel Design Features. Special features of the design and construction of the North American P-51 Mustang fighter have recently been revealed. Events leading to the completion of the design are traced from the date in April, 1940, when the British Purchasing Commission started negotiations with the North American company, and the way in which the design was finished to the point of test flight within a period of 120 days are related. It is noted that the laminar-flow wing was decided upon, despite the fact that the type had never been used before. Differences between the wing as finally adopted and the section as designed and tested by the N.A.C.A. are noted. It is of full cantilever, stressed-skin construction, the details of which are given briefly. The next most important feature, in the opinion of the North American engineers, is the fuselage, believed by them to be the smallest cross-sectional area to be placed behind an Allison engine. The features of the fuselage design and the changes made as the result of experience, as well as that of the power plant and its mounting, are discussed. An original design of structural aluminum engine mount instead of the conventional welded steel type is used. Details of the oil piping, air intake, and hydraulically operated landing gear complete the description. *Aviation*, June, 1943, pages 234, 237, 361–363, 7 illus.

Tailless Trials. G. M. Poulsen. A detailed description of some tailless biplane and monoplane wing designs conceived by Col. J. W. Dunne during the period of 1905–1913. Automatic stability, two-control flying, and tricycle undercarriages were features that distinguished these pioneering experimental models. Although differing in various respects, all early Dunne biplanes possessed back-swept, twisted wings and employed ailerons near the wing tips. Between upper and lower wing tips were fixed vertical panels corresponding to the fins of the orthodox aircraft and designed to provide directional stability. The trailing-edge flaps on upper and lower planes served both as ailerons and elevators.

Foreshadowing a development incorporated in the modern Northrop "flying wing," a Dunne monoplane of 1911 had downturned wing tips that carried the controlling surfaces. *Flight*, May 27, 1943, pages 556–558, 4 illus.

Engines

New Gas Turbine Projects. This article on gas turbines is devoted to a discussion of constant-pressure systems operating on a closed cycle. To explain the difference between the open-cycle principle and closed-cycle principles, however, the operation of the open-cycle, constant-pressure combustion gas turbine with regenerator is outlined with the aid of a schematic diagram. The writer then outlines the operation of the Escher Wyss closed-cycle, constant-pressure gas turbine plant with the use of a second schematic diagram. This Swiss design of turbine plant is provided with an oil or gas-fired furnace. The working medium is compressed, warmed, heated, expanded, and cooled ready for recompression in a completely closed circuit.

It is stated that working under ideal conditions with no loss it can be shown that for specific maximum and minimum temperatures of the medium the thermal efficiency depends solely on the ratio of the maximum and minimum pressures and not on the absolute magnitude of the pressures. The lower the pressure ratio, the higher the efficiency. In practice, of course, heat is lost. Nevertheless, the principle holds good approximately for a system in which losses occur. While a steam plant requires high pressures and high temperatures to achieve efficiency, in the closed-circuit gas turbine plant it is not necessary to raise pressures to improve efficiency. Thus it offers the possibility of substantial advantages in weight, first cost, and maintenance of both the main units and also the valves and control equipment. Other advantages of the closed cycle principle are mentioned.

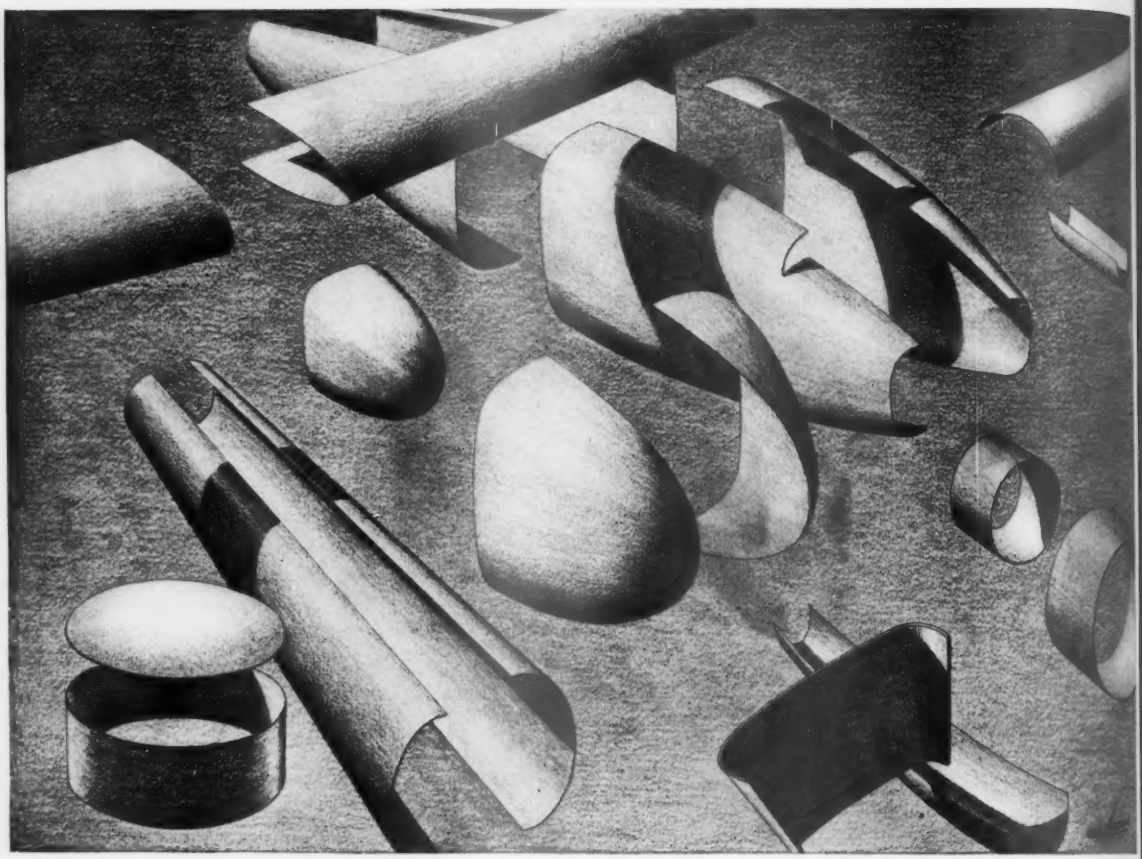
The English Electric Company of England also has a project for closed-circuit turbine plants using monatomic gas as the working medium. Features of this system are outlined. A proposal to employ a liquid medium in a closed thermal cycle to operate a turbine specifically for driving an airscrew, which comes from B. B. Holmes in the United States, is discussed. Details of the Holmes design are described and illustrated. *Flight*, May 8, 1943, pages 473–476, 6 illus.

Ford's Centrifugal Cast Cylinders. Chester S. Ricker. The Ford Motor Company's method of making centrifugally cast steel cylinder barrels for aircraft engines is detailed. It is claimed that not only are the cast cylinder barrels superior in strength to forged ones but also that their use saves 35 lbs. of steel per barrel and two-thirds the equipment costs. Characteristics of both types of cylinder barrels are compared and a step-by-step description is given of the machining process by which Ford's previous experience with centrifugal casting is applied to aircraft engines. *Aviation*, June, 1943, pages 134–137, 331, 12 illus.

Shot Blasting to Increase Fatigue Resistance. J. O. Almen. It is stated that it is doubtful whether more net work is being obtained from metals today in dynamically loaded parts than was obtainable 25 years ago and that no super-strength-alloy discoveries seem imminent. The writer emphasizes, however, that much can be done to increase the fatigue strength of many machine parts made from ordinary structural steel materials by extending processes already known to be satisfactory and avoiding practices that reduce fatigue strength. There are today new concepts of fatigue failure. Fatigue failure is held to result only from tension stresses, never from compressive stresses. Any surface, no matter how smoothly finished, is a stress raiser. Structural materials are not rigid. Many fatigue failures can be traced to elastic deflection for which no allowance was made in design.

From experience with practical machine parts, it can only be concluded that stress calculations by textbook methods are wholly inadequate unless generously tempered with experience. The accuracy of stress data from photoelasticity, brittle lacquers, extensometers, and similar methods is usually greater than by mathematical analysis, but these are far from reliable.

As a working hypothesis, it seems reasonable to assume, except possibly



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for ductile metals, that the slope of the fatigue curve, as measured on a log-log plot, is a measure of effective stress and that fatigue curves for varying stress concentrations converge toward a point near the tensile strength of the material at some considerable number of stress cycles.

Fully 90 per cent of all fatigue failures occurring in service or during laboratory and road tests are traceable to design and production defects, and only the remaining 10 per cent are primarily the responsibility of the metallurgist as defects in material, material specifications, or heat-treatment.

Study of fatigue of materials is the joint duty of the metallurgic, engineering, and production departments. There is no definite line between mechanical and metallurgic factors that contribute to fatigue. This overlapping of responsibility is not sufficiently understood. It is stated that, until more time is devoted to searching for mechanical causes rather than metallurgic causes, the full use of materials cannot be realized. *S.A.E. Journal*, July, 1943, pages 248–268 (Transactions), 42 illus.; "Surface Finishing Methods for Aircraft Engines," Franklin M. Reck, *Aero Digest*, June, 1943, pages 213, 215, 217, 218, 223, 329, 330, 14 illus.

Power Plant Performance. Roy E. Marguardt and Robert De Vault. This is one of a series of articles on power-plant performance. It deals with the determination of power available. The discussion is divided into two sections—one on the power produced by an engine at sea level and at altitude and the other on propeller losses. Sections of the article cover the prediction of power by weight-flow method, estimation of carburetor airflow, altitude performance of sea-level engines, and the altitude performance of critically supercharged engines. *Western Flying*, June, 1943, pages 76, 80, 82, 84, 86, 88, 92, 15 illus.

Aircraft Engines on the Production Line. H. E. Linsley. The effect of the war on aircraft-engine production is discussed. It is stated that three years of war production have created a revolution in manufacturing methods such as could not, in all probability, have been achieved in a quarter of a century of peacetime. As late as 1938 the manufacture of aircraft engines was virtually on a custom-built basis. With the outbreak of the war and the sudden demand for thousands of engines of a single type, it became feasible to consider the possibility of line production. The change from low to high production was not achieved immediately.

In the beginning, little special tool equipment was available. Many of the machines it was planned to use required as much as a year to design and build. One of the first steps was to obtain such special equipment as could be made or adapted in a comparatively short time and, with the help of this and large numbers of standard machines, get schedules under way. Illustrations show examples of this transition and serve as a representative cross section of the types of equipment now in general use. The writer describes how high-speed machine tools improve accuracy and discusses conveyer equipment essential for high production. The translating of production knowledge to peacetime tasks is discussed in the closing paragraphs of the article. *Mechanical Engineering*, July, 1943, pages 493–496, 10 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Aero-Engine Manufacture in Wartime. Group Capt. F. R. Banks. The Deputy Director-General of Engine Production in the British Ministry of Aircraft Production discusses problems connected with the wartime production of aircraft engines and explains how Britain is solving them. He states that it is only by intensive development that a successful engine can be put into full production uninterrupted (relatively) by modifications. Many modifications have to be faced, but major modifications that are chargeable to lack of development or to ineffective development have a disastrous effect on production. The value of an efficient development department is stressed.

England's three principal parent firms are listed as Bristol, Rolls-Royce, and Napier. Other factories building aircraft engines are stated to be not concerned with development but only with production. These plants are in most cases known as "shadow factories" but are, in fact, large government-owned and managed factories. The close liaison between aircraft-engine and aircraft construction firms is noted. Discussing actual engines, reference is made to the Rolls-Royce Merlin liquid-cooled engine in its latest form; the Bristol Pegasus and Bristol Mercury poppet-valve air-cooled radials, which are still giving valuable service in operational aircraft; the Bristol Hercules sleeve-valve engine, which is now in full production; and the Napier Sabre liquid-cooled, 24-cylinder H-type engine, which has yet to win its spurs in war but which is stated to be the most compact engine yet built for horsepower of 2,000. *Indian Aviation*, March, 1943, pages 67–70, 1 illus.

The Repair of Damaged Aero-Engines. How Bristol Hercules sleeve-valve aircraft engines damaged by enemy action or accidents are repaired. Inspectors categorize incoming engines as (1) repairable; (2) considered to be damaged beyond repair; and (3) investigation engines, on which special investigation of some alleged failure has been requested. It is stated that engines damaged beyond repair will often give, when stripped down, a varied selection of good components, particularly small items. These parts are subjected to rigorous acceptance tests.

Repairable engines are subdivided into five classes. The degree of stripping depends on the amount of repair required and the previous history of the engine as given by its log book, though most engines are 100 per cent stripped. Details regarding the cleaning, inspection, and repair of the engine are given. Engines free from heavy carbon deposit are washed off in paraffin and submitted for inspection. The majority, however, have to go through a longer decarbonizing and degreasing process.

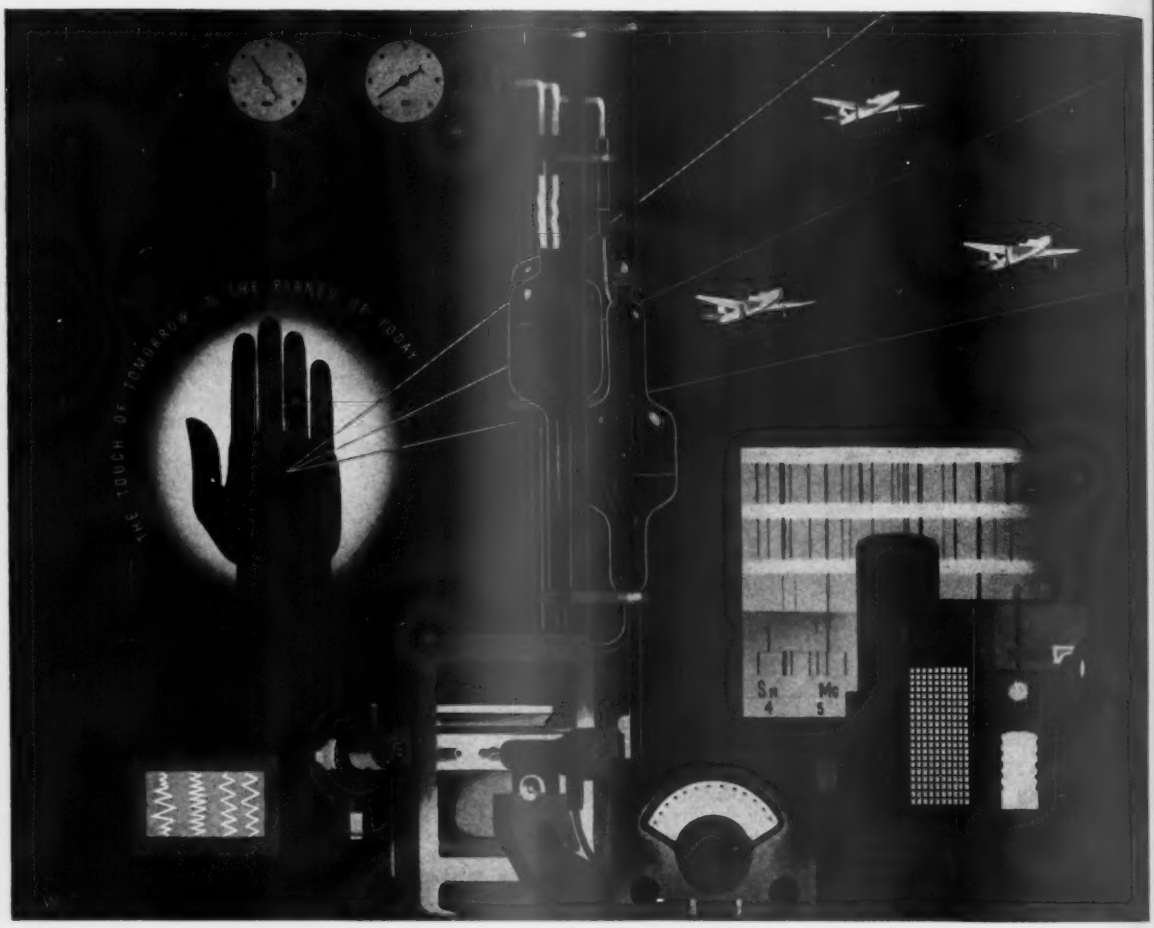
Aluminum components are subjected to an etching process for the detection of cracks and flaws. Steel components are tested for cracks by either the Magnaflux or Electroflux method. Every component, even nuts and washers, is most carefully inspected, the smaller and simpler parts being inspected by female labor under male supervision. Details are recorded on standard report forms that entail the minimum of writing. *The Engineer*, June 11, 1943, pages 470–475, 10 illus.

Piston Rings of Gray Iron. Tracy C. Jarrett. Reasons are given why gray iron is the most widely used material for piston rings. The composition and hardness of typical aircraft-engine and Diesel piston rings are described. It is stated that rings for aircraft engines must have a fine-grained structure, while Diesel and steam engines require rings of a coarser-grained material.

It is emphasized that close metallurgic engineering control is necessary in the manufacture of piston rings to insure good machinability and to meet stringent physical requirements. Close foundry control also is necessary. In the United States, piston rings are practically all made from individual castings. Photographs show the microstructure of gray irons for piston rings and piston ring molding operations. *Metals and Alloys*, June, 1943, pages 1188–1195, 18 illus.

Gliding and Soaring

Troop Transport Glider Gets Detachable Engines. The announcement of successful flight experiments with self-powered gliders leads to speculation on the strategic and tactical possibilities of such aircraft. An



Organizing Atoms for a Better Aircraft Engine

A visitor at the Ranger plant once remarked: "Scratch a Ranger engineer and you'll find a scientist!" In creating the Ranger in-line, air-cooled aircraft engine, Ranger engineers began by concerning themselves with the very atoms of which its metal alloys are composed. They made use of scientific instruments and techniques unexcelled anywhere in the world in scope and precision. And the same advanced metallurgical and chemical laboratory facilities are today guarding the quality of Ranger materials in the rush of war-time production. Spectroscopic, chemical and X-ray analyses of materials and finished parts are as much a part of Ranger production as milling machines, turret lathes and grinders.

All Ranger engines are put through the acid test of actual operating conditions in scientifically equipped test cells. Ranger's experimental test cells can simulate flying conditions in temperatures as low as —70° F. and at altitudes up to 40,000 feet. Some of Ranger's tests on auxiliary devices are not duplicated anywhere in the aviation industry. In Ranger's "flying laboratory"—a tactical war plane fully equipped with scientific test instruments—pilots and engineers daily add new knowledge to all that has been discovered before.

"ON THE BEAM"

"The independence and liberty you possess are the work of joint councils and joint efforts, of common dangers, sufferings and successes."

—Geo. Washington's Farewell Address

Buy U. S. War Bonds and Stamps

While thousands of Ranger engines are turning in a remarkable record in the planes of the United Nations, Ranger engineers persist in researches which will make even more readable news tomorrow . . . except in Axis newspapers.

RANGER AIRCRAFT ENGINES

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important phase of this development is that completed and tested transport gliders could be motorized temporarily and flown to their destination.... thus eliminating the necessity for disassembling them, crating them, shipping them by rail, and reassemblying them in the areas in which they are to be used.

The experiments referred to are those conducted between the Northwest Aeronautical Corporation in Minneapolis and Wright Field. Standard CG-4A glider types were used, powered by two six-cylinder, air-cooled, horizontally opposed Franklin engines. *Aero Digest*, June, 1943, pages 173, 334, 2 illus.

High-Altitude Flying

Cabin Supercharging in Scheduled Airline Operation. R. L. Ellinger. The supercharging of airplane cabins for high-altitude flying is discussed. It is explained that many small problems outside the field of aeronautical engineering had to be solved before success was attained. The system described by the writer is provided with two engine-driven superchargers that bring fresh air in from the leading edges of the wings. An alternate system brings in air caught by scoops located on the top of the fuselage. Each of the superchargers has a control unit located inside the cabin. The subject is dealt with under sections covering high-altitude tests, sealing, maintenance and testing, cabin sealing, supercharger problems, hydraulic power boost, cabin heating, and moisture absorption. The results of the experience with this equipment are evaluated. *S.A.E. Journal*, July, 1943, pages 241–247 (Transactions).

Stratosphere Research. Two detailed descriptions are presented of laboratory equipment for the testing of human physiologic reactions and the functioning of mechanical pressurization systems under high-altitude conditions. One investigates the design, construction, and operation of the decompression chamber used by the R.A.F. for the testing of personnel; the other, the chamber constructed by the Lockheed Aircraft Corporation for testing the pressurizing equipment of all types of aircraft.

The R.A.F. decompression unit described is a mobile chamber that does not reproduce the cold experienced at high altitudes but permits the pressure of air in the chamber to be altered at will, enabling the main physiologic effects of decreased atmospheric pressure to be demonstrated. It is a welded steel tank made from half-inch boiler plate, mounted on a standard Brockhouse 5-ton trailer. Cylindric in shape, it is 7½ ft. in length and 5½ ft. in diameter and has seating accommodations, oxygen equipment, and intercommunication telephones for six people. The article reports how climb and descent are simulated and presents figures on the effects of different altitudes and rates of climb on the human system.

Northwestern Aeronautical Corporation's glider equipped with detachable engines.

The Lockheed pressure chamber is a cylindric steel tank 24 ft. long by 6 ft. in diameter, with a shell thickness of ⅜ in. A diagram illustrates the general layout of the chamber and its division by a steel bulkhead into two equal compartments....one of which simulates the aircraft cabin and the other the atmosphere through which the aircraft flies. A cam-operated pressure regulator is provided for automatically controlling the pressure within the latter chamber to enable the performance of superchargers and their controls to be checked under variable flight conditions. All pressure chamber machinery is operated from a remote control board. *Flight*, May 20, 1943, pages 528–531, 6 illus.

Instrument Flying

Instrument Approach. Robert N. Buck. Problems connected with instrument approach are discussed. It is explained that there are two parts to instrument approach, the instrument part and the contact. The object of an approach is to get contact down through an overcast, but actually an approach does not end until the airplane is safely on the ground. With the aid of diagrams, information on correct methods of instrument approach under various conditions is given. *Air Facts*, July, 1943, pages 24–34, 8 illus.

Instrument Approach by Radio Direction Finder. Part II. C. H. McIntosh. The conclusion of a two-part article explains the problem of approach under conditions of high wind, together with a plan for approaching under moderate winds without going through the procedure of boxing. The problem is worked out in eight steps. A coordinated crew procedure is set up under five headings, whereby it is stated that boxing and approach can be executed with a high degree of precision.

A procedure for approach without boxing is then outlined in 13 stages. It is shown that this type of instrument approach with a direction finder closely parallels the usual radio-range procedure, the chief difference being that directional guidance is furnished by the direction finder rather than by a radio beam. *Aviation*, June, 1943, pages 206, 207, 209, 320, 3 illus.

Instrument Cross Checks and Substitution. W. A. Straith. How ordinarily unrelated instruments can be used to check each other is described. The article explains how a group of instruments can be used as a substitute for one instrument that may become inoperative. Instructions are given for making checks on the airspeed meter, manifold pressure, and rate of climb and for comparing instrument readings with previous experience. Cautions and hints are offered to the instructor, and examples for the application of the instructions are included. *Air Facts*, July, 1943, pages 44–47, 3 illus.

Instruments

Radar—Aerial Watch Dog. Bradley Jones. A brief historic outline is given of the development of Radar for locating enemy aircraft and submarines. The men who have played an important role in its development are named. A brief description is given of how this radio device operates. *U. S. Air Services*, June, 1943, pages 19, 45; "Some Facts About Radar," *National Aeronautics*, June, 1943, page 44; "What Are the Facts About Radar," *Popular Science*, August, 1943, pages 66–70, 214, 8 illus.

New System of Spare Parts Selection Aids Production and Field Servicing. H. N. Droge. The development of a system for maintaining adequate

This is the first of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME

"Air Yachts and Flying Motorcycles"

says Harry Woodhead, President of Consolidated-Vultee Aircraft Corp.

"I WOULD LIKE TO SEE *an air force composed of thousands of all types of military aircraft of latest design—properly maintained, kept up to date by an extensive development program and able to get to any part of the globe within 24 to 36 hours to throttle, at birth, dreams of conquest by future Hitlers and Mussolinis.*

"I would like to see started immediately after peace comes an intensive program of development of domestic and transoceanic airlines carrying both passengers and cargo—and a more liberal policy to provide sound, service-improving competition on international routes.

"And I would like to see a sound plan to encourage private ownership of aircraft ranging from air yachts to flying motorcycles, resulting in the postwar maintenance of a reservoir of pilots who can be called upon in emergency. The bulk of such craft would be low in price with reasonable servicing facilities available. The government should furnish free use of airways, airports, landing strips and, through further development of electronics, provide safe means of blind flying, take-off, and landing. Simplified design of aircraft, making mechanical care easy, coupled with the above, should do for private aircraft what good roads and service stations did for the automobile."

Out of the broad thinking of men like Harry Woodhead and others who are charting the skies for our future, has come an aviation industry greater than any of our dreams—but an industry whose shape is yet to be determined.

In molding that shape, aviation has a great group of silent partners: the TIME-reading men and women on whom aviation focuses most of its advertising—the people who have the executive jobs, the income, and the habit-of-accepting-progress that will help fill aviation's transport and cargo planes, help fly aviation's family planes through the skies of the postwar world.

Believing that the ideas of aviation's leaders are always of interest to the aviation industry, TIME here begins to give them wider circulation in the name of

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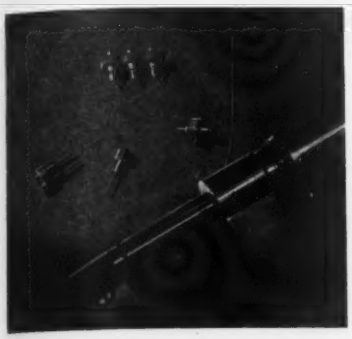

Some idea of the small size of precision parts for Kollsman instruments is given by comparison with a micrometer.

stocks of spare parts for instruments and to keep a steady flow of parts moving to the war fronts is related. The Kollsman Instrument Division of the Square D Company made a field survey and also recommendations that are credited with having improved greatly the methods for keeping instrument stocks and doing instrument maintenance work. Frequent reference is made to information incorporated in a 100-page booklet titled *Interchangeable Parts and Recommended Spares List*, published by the Kollsman Instrument Division. *Aero Digest*, June, 1943, pages 151–153, 8 illus.

Landing Gear

Aeroplane Wheels. The trend of airplane wheel and tire development in Great Britain is traced. It is stated that tires and wheels have not undergone such radical changes as Americans were prepared to accept. The "doughnut" or really low-pressure tire has not won acceptance in Britain, though increasing loads and the need to obtain low ground contact pressure led the industry to move away from the high-pressure tire. While there are exceptions, the trend has been toward tires of the intermediate pressure type in which a large volume of air is used to carry the large loads of modern planes, but a wheel of reasonable size remains to take the brake fittings. The subject of meeting heavier loads is discussed. Checks and tests of tires and valves are described. *The Aeroplane*, May 28, 1943, pages 620, 621, 4 illus.

Levered Suspension Landing Gear. John A. Zagusta. The operation of various types of landing gear is reviewed, with information on the forces encountered in the landing of an airplane, the problems that are met, and the principles of the levered-suspension gear. An analysis of the forces and energies involved in landing is worked out mathematically, and the advantages of the levered-suspension type of gear are emphasized. *Aero Digest*, June, 1943, pages 161, 162, 165, 167, 169, 321, 324, 11 illus.

Lighter-Than-Air

America Has a Corner on Balloon Juice. Jean Ackermann. The wartime uses for helium, which is produced only in America, are described. The increased demand for helium is said to be partly attributed to the raising of the Navy's blimp patrol from 23 to 151 aircraft. It is noted that four new plants under construction will bring the production of helium to 40 times the prewar output. The advantages of helium for use in balloons are outlined. *Popular Science*, August, 1943, pages 89–91, 202, 8 illus.

British Barrage-Balloon Secrets. Operational details are given about the barrage balloons used in Britain's defense network. It is explained that these balloons fall into two categories. One type stays in the air most of the time, being hauled down only for repairs or reinflation. The other type is raised only during an "alert." Each balloon is held captive by a steel cable that winds on a winch mounted on a truck trailer. The balloons are handled largely by the W.A.A.F. *Popular Science*, August, 1943, pages 58–60, 7 illus.

Maintenance

Fighters and Bombers Fly Home for Repair. John Foster, Jr. Demonstrating the Air Service Command's system for fourth echelon maintenance, the activities of the Oklahoma City Air Depot are covered in detail. The article follows a typical plane through the various stages of overhaul, showing how each part of the aircraft is subjected to inspection and reconditioning. It also describes operations other than maintenance carried out at this center. These are connected with the Depot's additional functions as a supply depot, air freight terminal, training department, and modification center-intelligence unit.

In detailing the maintenance techniques employed, the article also notes several devices that illustrate the ingenuity of the Air Service Command. One is a hydraulic jack for raising into position the main oleo struts of heavy bombers. Another is a bungee stretcher in which a hydraulic jack stretches the bungees to the point where a spread bar may be inserted. *Aviation*, June, 1943, pages 120–123, 364, 367, 368, 371, 372, 375, 14 illus.

New Ford Prop Changer Simplifies and Speeds Field Handling. A brief description of a quick and simple method for mounting and removing propellers on the field or at an airport. Innovated by the Ford Motor Company, this system utilizes a propeller hoist mounted on a tractor in place of the heavy steel platform formerly used. A hydraulic pump driven by the tractor engine through a standard power take-off shaft raises

Tenite inspection hole covers. These covers are designed to fit flush with both the exterior and interior of the plane.

a platform from which five mechanics can work. *Aero Digest*, June, 1943, page 176, 3 illus.

Fire Protection. Herman Schlosser. Advice is given on how to avoid fires in airplane maintenance and overhaul bases. The writer's recommendations cover points on planning, constructing, and equipping a maintenance station so that fire hazards will be reduced to a minimum. In addition to general precautions for fire protection common to all industrial buildings, he surveys special precautions that apply to the particular problem.

The following are included in the rules laid down for the planning of hangars, shops, and stockrooms: Hangars must be separated; welding and, insofar as possible, spraying should not be permitted in hangars; separate areas, properly enclosed with fire walls, should be provided for such operations and functions as engine testing and disassembly, battery charging and repairing, plating, upholstering and fabric covering, paint spraying and doping, and carburetor testing; stockrooms should be separated from hangars and shops and provided with adequate aisles as well as metal storage bins and racks; an isolated building should be provided for the housing of water-storage tanks, pumps, and equipment for supplying the stand-pipe and sprinkler systems. The construction pointers refer to shops and stockrooms as well as hangars. Necessary emergency equipment is listed and a course of training for fire brigades is suggested. *Southern Flight*, June, 1943, pages 32, 34, 39, 51, 3 illus.

Servicing the "Glass" in Small Planes. A. R. Foil. The servicing of plastic windshields, windows, and skylights of small aircraft is explained. It is stated that the loosening of this flexible material, which may cause an accident, commonly results from mak-

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America won a victory on the food front in 1942 with production that reached an all-time high. But even that wasn't enough to feed a hungry, war-torn world. So this year's objectives are higher.

Farmers need mechanical equipment to produce food in winning quantities. Now, with the critical shortage of skilled farm labor, modern machinery becomes vitally important.

Agricultural equipment engineers have steadily improved farm machinery, lowered costs, and educated users. Result: no nation's farms were ever so fully mechanized as ours. And repair and service facilities have kept pace so farm equipment keeps working without excessive breakdowns or delays.

The foresight of these engineers is shown by their repeated specification of materials strengthened and toughened with Nickel. Their experience proves that a little Nickel goes a long way in the manufacture of parts that stay on the job . . . stressed parts that stand shock overloads.

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ing it too tight. When installing such transparent plastics the bolt holes should be enlarged to provide proper clearance and avoid strain. The cleaning of windshields and windows is discussed. The use of dirty rags will cause scratches, which hold the dirt, cut down visibility, and furnish the starting point for the breaking of the entire sheet. Cleaners with a solvent action should be avoided. *Aviation Service Magazine*, May-June, 1943, pages 8–12, 39, 9 illus.

Mass Production Overhaul. John H. Connelly. The production-line overhaul system employed by the Southwest Aircraft Corporation for the periodic inspection, maintenance, and repair of Army Air Forces training planes is outlined. Each component of the plane is followed briefly through the various stages of disassembly, cleaning, inspection, reconditioning, and reassembly to which it is subjected. The article shows how the techniques of breaking down operations into standardized divisions and maintaining a constant flow of materials past specialized workers have been applied with most efficient results to the job of overhaul. A diagram charts the production flow of the system.

Located at Thunderbird Field in Arizona, the station receives from two sources planes to be overhauled. One source consists of three training fields operated by Southwest (two for the A.A.F. and one for the R.A.F.); and the other is the San Antonio Air Depot, which orders trainers from other schools to be flown in for depot inspection and repair. *Aviation*, June, 1943, pages 213–215, 378, 381, 382, 5 illus.

Flying Battleships. A review is given in nontechnical language of the maintenance operations performed on the Short Sunderland. Its structure, bomb stowage, control surfaces, power plants, tail and flaps, and lubrication are the headings under which the information is set forth. *Air News*, June, 1943, pages 23–25, 6 illus.

Controlled Maintenance. A system of line maintenance used by United Air Lines, designed to provide for the most efficient employment of the limited amount of equipment now available, is outlined. The forms for handling the office work and communications were developed to meet the needs of the entire system, and these are given credit for an important part in the satisfactory operation of the plan. The kinds of work done at the major service stations and at the Wyoming central overhaul base are described, as well as the duties of the equipment-utilization engineers and the methods they follow. Three grades of service checks are detailed, and results are contrasted with former methods. Credit is given to the men who direct this work. *Aviation*, June, 1943, pages 216, 346, 347, 349, 3 illus.

A jig used by United Air Lines at its central maintenance base at Cheyenne in obtaining more accurate measurement in rigging of elevators and rudders than was possible by former methods. The jig consists of two 1020 steel plates, 0.125 in. thick, attached to the elevator torque tube bearing supports on the airplane's stabilizers and braced in between with four pieces of $^{5}/_{16}$-in. tubing. The device allows for the checking of one elevator against the other and determines the setting against the centerline of the stabilizers. The setting of elevator and rudder stops can be accomplished with ease.

Management

Absenteeism Under Control at Vultee. Adrian R. Baish. The Vultee Field Division of the Consolidated Vultee Aircraft Corporation has reduced its all-over absentee rate to 3.3 per cent of the workers. In this article the supervisor of employee service describes the various methods used by the company to control absenteeism. An active Employee Service Department, a busy post office, and a well-stocked general store are features of a plan designed to free workers from the necessity of taking time out. How the Employee Service Department operates is described. Bills of the employees are paid through this office. Among other services, traffic fines are settled, jury duty calls are straightened out, and hunting and fishing licenses are obtained. The store is employee-operated and profits go to finance employee activities. *Automotive and Aviation Industries*, June 15, 1943, pages 22–24, 74, 5 illus.

Growth of Wartime Aircraft Organization. E. W. Walker. A study of the basic types of organization suitable for aircraft companies and of some of the problems attendant upon organizational changes caused by wartime growth. A series of nine charts is presented as a guide in choosing the best organization for the particular size of aircraft company involved.

The four types of organization outlined are: (1) the line or military organization, based primarily on discipline; (2) the functional organization, in which lines of authority and instruction pass from each supervisor to each foreman; (3) the line and staff organization, combining some of the advantages of both the line and functional types of organization; and (4) the committee organization, which is a modification of line and staff organization calling for the division heads to serve as a committee acting on various policies and authorizing control procedures. The best form of company organization for growing aircraft companies is indicated as a compromise between the line and staff organization, with the introduction of a certain amount of committee organization. *Aero Digest*, June, 1943, pages 247, 249, 251, 324, 10 illus.

Materials

Design-Strengthened Materials. Richard S. Smith and Hamilton Gray. The purpose of this paper is to present pertinent design data and descriptive information on a process for increasing the strength-weight ratios of flat sheets of high-strength steel, aluminum alloy, and other metals.

Briefly, "design-strengthening," as the process is called, is accomplished by passing sheet and strip through specially prepared rolls that have, on their surfaces, a pattern that is transferred to either the top or bottom surface of the flat sheet or to both surfaces. The patterns are designed to improve such characteristics of the sheet—resistance to impact, stiffness, buckling strength, fatigue resistance,

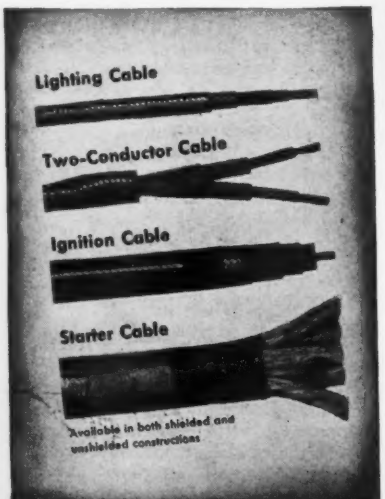
IT'S WIRY JOE FOR AVIATION WIRE and CABLE

There *was* a time that Wiry Joe was merely the largest independent manufacturer of replacement wiring for the automotive industry.

Now, Wiry Joe is also known as an important source of supply for every type of electrical wire and cable for aircraft. The complete line includes starter cable, high-tension cable, primary cable, both original and replacement. Wiry Joe also makes power and welding cable.

And just as Wiry Joe automotive cable won a name for quality, so, too, has Wiry Joe aviation cable. Every item in the line is built to meet rigid Army and Navy specifications, and is produced under the Dostam method of manufacture for uniformity, dependability, high efficiency and long life.

Inquiries regarding wire and cable for any type of service will be answered promptly.



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etc.—as may be dictated by the structural requirements.

Tables of properties of the several design-strengthened materials are presented. In these tables the properties of the original flat sheets are given for comparative purposes. *Journal of the Aeronautical Sciences*, July, 1943, pages 213–217, 5 illus.

Conservation Starves the Scrap Barrel. C. C. Shafer. Focusing attention upon the opportunities for eliminating wasted materials before actual production is begun, the writer suggests methods of material conservation through the work of the planning, engineering, and tooling departments. He explains how the most efficient means of conservation find their inception in design engineering and proper production planning for maximum material use, illustrating his points with conservation procedures of the Consolidated Vultee Aircraft Corporation.

The company's Material Specification Planning Group is responsible for the definite determination of stock requirements for each part; means are then devised for improving existing fabrication methods. Specific improvements in fabrication and operational methods—initiated by the Production Department and the Engineering Department—are described. *Aviation*, June, 1943, pages 138–142, 320, 15 illus.

Sponge made from Koroseal, the plasticized polyvinyl chloride developed in The B. F. Goodrich Company laboratories.

Effect of Scratches on Fatigue Strength of Alclad Sheet. H. J. Andrews and G. W. Stickley. Tests are described which have been devised to show that scratches more severe than those encountered in service do not seriously affect the fatigue characteristics of Alclad sheet. The writers discuss the terms ordinarily employed in specifications to cover defects in materials. Existing specifications for surface quality of aircraft metals are referred to, and experiments concerning the depth of scratches and tests to determine the effects of such scratches are described. Results are tabulated and illustrated by charts, drawings, and photographs.

In summarizing the results of tensile and fatigue tests, the writers conclude that even deep scratches have no effect upon tensile strength and

FLEETWINGS
pioneers with parts and hydraulic equipment

The BT-12, all-welded basic trainer built for the U. S. Army Air Forces.

VICTORY (rivets) IN THE BAG! The simple but ingenious trick of keeping rivets in little transparent bags, sorted for size, promises to result in a four-to-one saving in rivet cost at Fleetwings. By bagging the rivets, waste is virtually eliminated, mixing of sizes is negligible, and the heat-treated rivets harden less quickly because they are protected from outside air.

14 FLEETWINGS WORKERS WIN PRIZES! For suggestions to step up production and increase the flow of war material to our boys at the front, Fleetwings distributed cash awards to fourteen Fleetwings workers last month.

BACK IN 1937 when Fleetwings produced its first hydraulic valve, the production figures of today would seem fantastic. From that first valve (used on the pioneer stainless steel plane, the Seabird) has sprung Fleetwings' complete line which includes gun turret valves, single unit flap control valves, and solenoid-operated valves (automatic).

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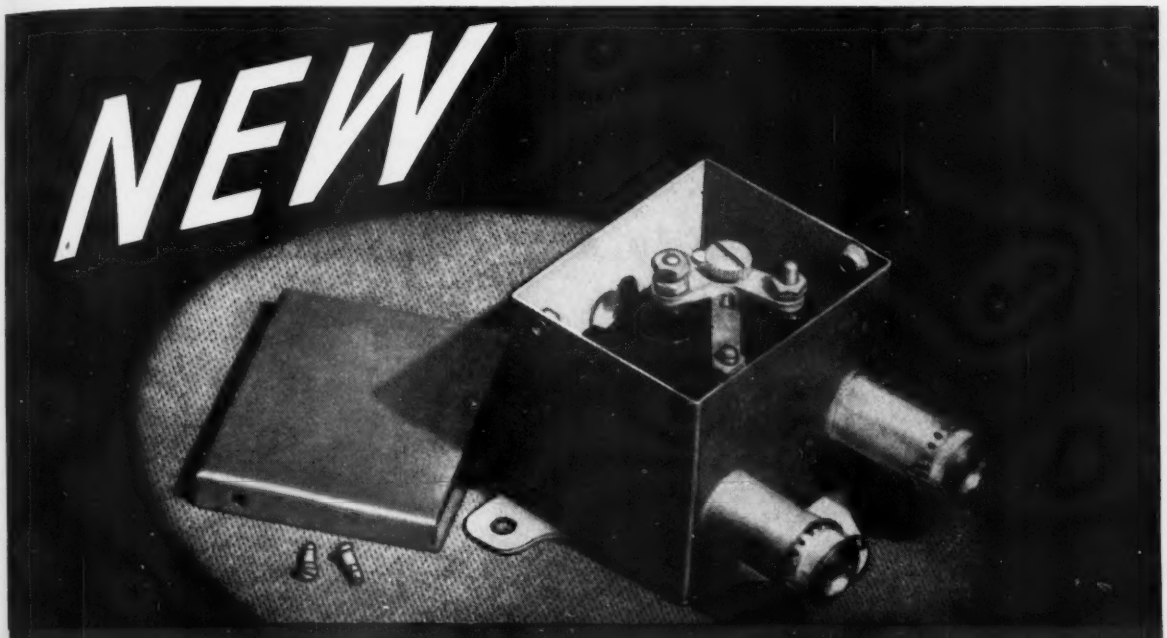


A G-E STARTING VIBRATOR FOR AIRCRAFT

Over-all size: 4⅝ by 4⅝ by 2⅞ inches
Weight: 2 pounds

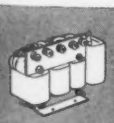
For quicker, easier engine starting REGARDLESS OF MAGNETO SPEED

From the Aleutians to the Sahara—at almost any temperature—this new G-E starting vibrator helps provide instant ignition, which means quick, easy engine starting. A pulsating, low-voltage current is applied direct to the low-voltage winding of the magneto, and is stepped up by transformer action within the magneto to provide a high-voltage output, regardless of low magneto speed.

Highly efficient. Power losses are minimized, battery-current drain is low, and radio interference is almost completely eliminated. The vibrator operates only during the starting cycle; it is then automatically disconnected from the ignition circuit.

Sturdy construction. External parts are thoroughly protected against corrosion. A plated-steel case provides durability and strength. Coils are embedded in a specially developed, high-melting-point, moisture-resistant insulating compound. The vibrator is protected by a special relay against inductive voltage surges from the magneto. *General Electric Company, Schenectady, New York.*

IMPROVE AIRCRAFT ELECTRIC SYSTEMS WITH THESE G-E TRANSFORMERS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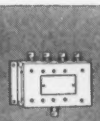
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Seaplane floats must meet the test of war-service conditions on rough water and hard beaches—and *must not leak*. Watertightness is assured by processing metals to make them resistant to wear and corrosion and by numerous special, precise operations—including the sealing and minute testing of every rivet! Simplicity of design and accessibility to every part of an Edo float saves valuable work-hours in these vital processes and aids efficient inspection.

At left: An Edo float on a special jig undergoes a water test. Every compartment is filled individually and subjected to closest inspection, inside and out, for leakage. *At lower left:* An operator inside a compartment tests the watertightness of adjoining sections which have been filled with water. *Lower right:* A joint between adjoining sheets is treated with a ribbon of sealing compound .010″ thick which remains plastic and keeps the joint leak-proof.

Making floats watertight—is a job at which Edo has had 18 years of continuous experience in preparation for its big job of today in building the world's finest all-metal floats for our military seaplanes.

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yield strength and only a small effect upon elongation and fatigue strength, noting that the conditions imposed were undoubtedly much more severe than those that occur during normal handling of Alclad sheets. The ruling that scratches that do not penetrate the aluminum coating and into the core are not cause for rejection is approved by the writers. *Aviation*, June, 1943, pages 154, 155, 157, 5 illus.

Medicine

Medical Research in Some Aspects of Aircraft Design. William E. Russell, John R. Erwin, and Hugh R. DeHaven. It is observed that the rapid evolution of aircraft design has removed many of the hazards attendant upon flying in earlier times but has brought new problems for the medical profession calling for the improvement of the physical abilities of flight personnel to make full utilization of the advances in the aircraft they are flying. Physiologic limitations and the functions of aviation medicine in the aircraft industry are discussed with special reference to the factors that make unique the application of medicine to flight work.

A program for the maintenance of the health of flight personnel is outlined, and the work of the Boeing Aircraft Company in the expansion of high-altitude flying through its extensive research in that field is described. Statistics are compiled on the records established by the Boeing flight-test crews. Among the subjects investigated are aerophysema, oxygen, and pressurizing equipment. A section of the article deals with injuries resulting from aircraft accidents, analyzing the causes and preventive measures for injuries in major and minor accidents. Types of structures designed to minimize the effects of accidents are reviewed and a program of experiments is projected, to facilitate further progress in this field of research. *Journal of the Aeronautical Sciences*, July, 1943, pages 227–231.

Hitting the High G's. Eric Sloane. A study of the physiologic effects of abnormal accelerations upon the human system. Reactions to the pull of gravity are followed through from 1*g* to 8*g* and the sensations caused by various flight maneuvers—such as greatly accelerated dives and tight turns—are examined. The "black-out" and "red-out" are explained. The article also considers briefly the physiologic effects of high altitudes, together with methods of combating them. *Skyways*, June, 1943, pages 38, 39, 69, 1 illus.

Development of a Medical Service for Airline Operations in Africa. This is the second part of a two-part article on the development of a medical service for an African air line. Infectious diseases of the gastrointestinal tract—that is, diarrheas and dysenteries—are discussed. Other subjects covered include general medical problems, psychiatric problems, and surgical problems. A summary of conclusions and also an appendix containing health rules are included. *War Medicine*, June, 1943, pages 619–634.

Metallurgy

The Metallurgy of Modern Alloys. R. H. Harrington. The sixth of a series of articles on heat-treating definitions for modern alloys. Reactions in the solid state of alloy systems, which are the basis of all heat-treatments, are discussed under sections covering "bi-variable" solid-solution phase boundaries, eutectoid inversions, direct allotropic alloy transformation, and intraphase transition horizontals. *Heat Treating and Forging*, June, 1943, pages 282–285, 302, 3 illus.

Meteorology

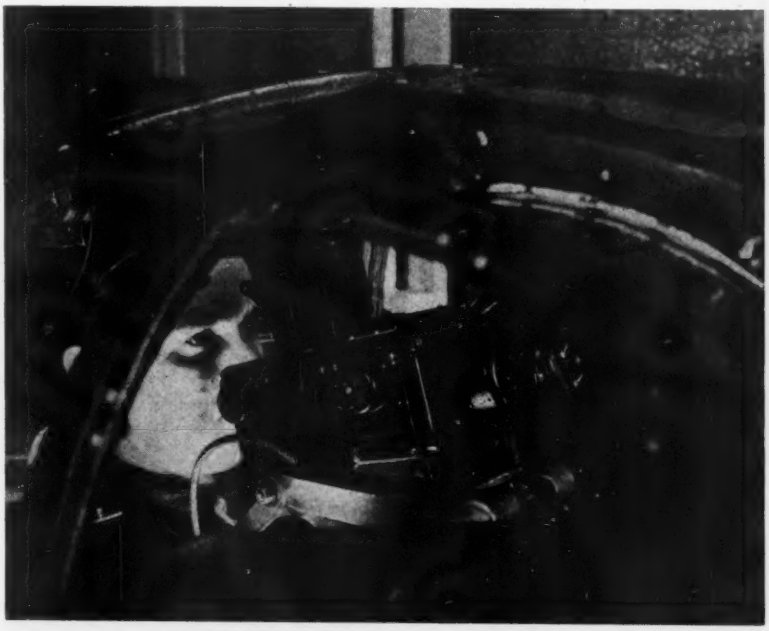
Cumulo-Nimbus Clouds Play Prank on Pilots. The experiences of the crew of a Short Sunderland with the effects of cumulo-nimbus clouds while on operational flight are recounted. The story is told of the way the strong upward current of air tossed the heavy plane about and how, when released, the plane hurtled downward through 3,000 ft. before its pilots could recover control. The causes of these currents are explained in non-technical language, as well as the effects of the electrical fields that develop in the vicinity of clouds of this type. *Air News*, June, 1943, pages 16, 17, 3 illus.

A Previsão do Temp (Weather Forecasting). Carlos Martins. A historical review on meteorology and its transition from the empirical into the scientific stage. The writer traces the ways by which weather forecasting has been developing through the ages. It was assumed that the moon in its various phases had a direct influence on the weather. Many rules were laid down, and all amateurish observations centered on the moon. As an example, an old saying: "If it thunders at the time of the new moon, there will be rain for the next 30 days," is stated to be one of the oldest weather rules.

The first step into the realm of scientific observation is said to have been made in 1744 by a minister of Banbury, England, who based his forecasts on formation and movements of clouds, formation of fog, and variations of the wind. Since then, meteorology gradually developed first into a domestic and afterward into an international weather service. *Revista do Ar*, January, 1943, pages 8–11.

Military Aviation

Lightnings Strike 'Cross the Sea. The story credited as that of the world's first transatlantic ferry flight by fighter aircraft is told. Scores of Lockheed Lightnings made the mass crossings recently and Lockheed field service representatives who accompanied the deliveries brought back the story of the flight. It is stated that only one of the planes was lost, although six others were damaged in



A Sperry 0.50-caliber computing sight in a Sperry-designed upper turret. (See page 187.)

making landings on a glacier when weather prevented them from locating an airport. After a stop in England, many of the P-38's continued to the African front for a Burbank-to-Africa journey of over 8,000 miles. It is pointed out that the fighters were especially equipped for the Atlantic voyage, carrying long-range oxygen equipment and droppable gasoline tanks. *National Aeronautics*, June, 1943, page 19, 1 illus.

Scoring the Box Score. A summary of Army Air Forces rules for scoring enemy planes as "destroyed," "probable," and "damaged." Only under three circumstances may an enemy aircraft be reported as "destroyed": (1) It must be seen descending completely enveloped in flames; (2) it must be seen to disintegrate in the air, as when a complete wing or tail assembly is seen to be shot away from the fuselage; or (3) if the plane is a single-seater and the pilot is seen to bail out.

To be considered a "probable" an enemy plane must be so thoroughly afire as to make it impossible for the crew to extinguish the flames, or it must be damaged to an extent that leads the American pilots to believe, from their own experience, that a plane so damaged could not land safely. An enemy airplane may be reported as "damaged" only when parts are seen to be shot away. *Flying*, pages 39, 158, 160, 2 illus.

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Naval Aviation

Mass-Production Carriers. Rex Sydney. The function and production advantages of the U.S. Navy's auxiliary aircraft carriers are related. These auxiliaries are converted from merchant ships and are designed for two principal tasks—to provide aerial escort for important convoys and to ferry relatively short-range planes to combat zones. While they are not regarded as substitutes for combatant types of carriers, they can be produced in large numbers at much greater speed and much less cost. Some details on the construction, equipment, and performance of converted carriers are included in the article. *Flying*, July, 1943, pages 24–26, 142, 5 illus.

Sea Fighter Air Cover. B. J. Hurren. A discussion of principles of air cover, as supplied to surface craft by carrier-borne fighter planes. Reviewing the record of sea fighters, the writer protests against any claim that carrier-borne fighters necessarily must be inferior in performance to land-based fighters.

In discussing the efficiency of carrier-borne fighters, the writer states that no important handicap is imposed at operational speeds by the carrier-based plane's extra equipment (such as arrester gear equipment and catapult spools) and that its speed is far in excess of the maximum speeds of bombers and torpedo-bombers attacking the ship. Comparing the sea fighters with land-based fighters, he states that if the carrier keeps its distance from land bases, as it almost invariably does, the extra loading of fuel required by the land-based plane more than outweighs the extra equipment needed for deck operation. *Flight*, May 13, 1943, pages 506–508, 4 illus.; "Escort Carriers," *The Aeroplane*, May 28, 1943, pages 618, 619, 5 illus.

Nine Lives Aren't Enough. Eddie Piersol. Highlights in the operational record of the Catalina PBY are reviewed briefly. It is told how, instead of conforming to theories that a ten-year old airplane design should be ready for discard, this patrol bomber has continued to serve sturdily on many fighting fronts. Exploits of the Catalinas with the British and American navies, over both the Atlantic and the Pacific oceans, are noted. *Western Flying*, June, 1943, pages 39, 74, 1 illus.

Paint

Finishes for Plywood in the Aircraft Industry. Roy B. Anderson. An article on paint, varnish, or lacquer type finishes for the type of plywood that is bonded with synthetic-resin blues. It is stated that the ideal finish must meet the demands of the aircraft designer and engineer for pro-

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"Corsairs" take off on AEROLS*
With remarkable smoothness, these Chance Vought fighters, called "Corsairs," race off the flat-top's deck. Enemy ships have been sighted and hunting prospects are good.
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*THE SHOCK ABSORBING UNITS ON AN AIRPLANE'S LANDING GEAR; THE NAME IS DERIVED FROM THE WORDS "AIR" AND "OIL"—THE FLUIDS USED TO DISSIPATE THE LANDING SHOCKS

tection, weight, smoothness, and service; the needs of the production department for easy and quick processing; and the requirements of simple and speedy refinishing in the field. The requirements of such an ideal finish are listed. Reasons why moisture resistance is a primary requirement for an ideal finish are given in sections covering the change in weight of wood with moisture absorption and the loss in wood strength with increased moisture content. The loss of strength properties for birch, with increasing moisture, is shown in a table. Information on the effectiveness of moisture-excluding coatings is given. Other subjects discussed include factors affecting the formulating of a finish, different types of coatings tested, and methods of application. Uses for plywood-aircraft coatings are listed. *Mechanical Engineering*, July, 1943, pages 506–510.

Personalities

They're Dreaming of Bright Skyways. W. B. Courtney. Brief character sketches of five leaders of the aircraft industry are accompanied by some data on the planes they are developing for postwar air travel. The men about whom the article is written are: Glenn L. Martin, Hall L. Hibbard, I. M. Laddon, Donald W. Douglas, and John K. Northrop. The airplanes discussed are: the Martin Mars, the Lockheed Constellation, a 400-passenger experimental plane planned by Consolidated Vultee, the Douglas C-74, and the Northrop Flying Wing. Part of the article is devoted to depicting the future of aviation—the speed, comfort, and economy of air travel after the war. *Collier's*, June 19, 1943, pages 16, 17, 70, 72, 74, 5 illus.

Personnel

Accident Prevention in Airplane Production. William S. Rhodes. A survey of some methods and routines by which airplane companies are protecting their workers from industrial accidents and illnesses. One method noted is the means of safeguarding personnel from punch-press accidents by redesigning the fixture so that the operator does not have to hold the part in the machine. Volunteer safety organizations; preemployment medical examinations; medical checkups; and periodic inspections of equipment, tools, working areas, and procedures are described. Other observations refer to the precautions taken for personnel who work around lead pots, paints, degreasing, and other operations where solvents vaporize and where workers are exposed to breathing the fumes. The problem of minimizing the dangers attendant upon grinding, cutting, and sawing of magnesium parts is also considered. *Flying*, July, 1943, pages 105, 106, 116, 119. 5 illus.

Photography

Aerial Cameras. J. A. Oates. An outline is given of the construction of the type F 8 aerial camera, together with a detailed description of the manufacture and assembly of certain major components at a Kodak factory. It is noted that this camera is used extensively by the Royal Air Force and incorporates many interesting photographic, electrical, and mechanical features. The equipment is manufactured on the batch principle, the same machine tools being used for a variety of operations. The writer discusses the design and operation of the camera, the methods of machining the body and lens cone, and the gauging equipment for assembly and inspection. Details are given on the production methods employed. *Aircraft Production*, June, 1943, pages 280–289, 29 illus.

Plastics and Plywood

Plastics and Their Application to Aircraft Construction. J. T. Zhibitsky. In this article, which originally appeared in *Aviation Industry, U.S.S.R.*, it is explained that in the Soviet Union economical organization and a practically inexhaustable supply of raw material are favorable conditions for the rapid development of the plastics industry. The advantages of plastics are outlined. The writer discusses the various types of plastics and their application to aircraft construction, the working of plastics, and applications of plastics abroad. *The Journal of The Royal Aeronautical Society*, May, 1943, pages 138–143.

Plastics Production. The facilities for the manufacture of plastics at the plant of De La Rue Plastics, Ltd., of England are described. It is stated that the plant is equipped to manufacture a wide range of plastic products, including aircraft equipment and supplies. Both paper and fabric are used for the laminates in the material manufactured by this company. The production methods are outlined. Operations in the section of the factory devoted to the manufacture of plastic resins and molding powders are described. A recent development upon which the factory is now engaged concerns a reinforced plastic material. This is a high-tensile plastic material with oil reinforcement. *Aircraft Production*, June, 1943, pages 299–301, 8 illus.

Thermoelastic C-Stage Laminates. E. F. Lougee. A process for producing standard aircraft parts using thermoelastic C-stage laminates is described. The writer explains how the chief plastics engineer of North American Aviation developed a method for making ammunition chutes, ejector hoppers, and ammunition boxes out of plastics. These parts formerly were constructed of metal. The hopper had to be seam-welded from four separate stamped parts to form the deep draw. It required a plastic lining to protect it from abrasion and denting caused by the empty shells ejected from the gun. Now the hopper is made in one piece of plastics laminate in less than 3 min., with a saving in both weight and cost. How other aircraft parts are made from phenolic laminated sheet is described. *Modern Plastics*, June, 1943, pages 69–71, 148, 8 illus.

A worker finishing the Lucite nose piece for the Martin 187 bomber. This is one of the largest plastic bomber noses now being made in this country.

Plastic Heating by Oil. J. Le Maire. An examination of the possibilities of using oil as a heating medium for plastic dies. Indicating the limitations of electric elements and steam, the article reports on the action and advantages of certain oils that have easy firing quality at low temperature. The equipment and operating costs for such techniques are said to be comparatively inexpensive. *Commercial Aviation*, May, 1943, pages 139, 140, 4 illus.

Stressed-Skin Wooden Construction. Part II. W. Stepniewski. The second part of an article on strength problems of stressed-skin construction is presented. The general trend of this examination is the rough definition of the optimum distance of ribs for bulkheads when the following are known: (a) outside dimensions of a component; (b) loads sustained by this component; (c) physical and mechanical characteristics of the skin; and (d) weight of a rib or bulkhead. Calculations are given for compressive and shear stress, basic relations are defined, and formulas are worked out for the estimation of optimum distance of ribs and bulkheads and of the load per inch of the circumference of the skin section. Some examples for changing of skin thicknesses are ex-

This is a chunk of Bornite—*weight 1¼ lb.*

Pretty, isn't it? But it takes a surprising lot of this "rock" and other copper ores to supply today's demands. A chunk of bornite this size is needed for the *single ounce* of copper in the cup for ONE caliber .50 tracer bullet jacket.

Nature doesn't give up its copper easily. It takes time to mine, crush and grind the ore, to smelt it . . . to refine the copper, melt and cast it. Only then is copper ready to be remelted and alloyed, cast, rolled or drawn into commercial shapes such as sheets, wire, rods and tubes—in quantities never before imagined possible—yet scarcely enough to go 'round. So we ask that you conserve it. Use it wisely.

Where is all the copper going? Everywhere. 950 lb. in an M-4 tank, 348,000 lb. in a submarine, 463,000 lb. in a destroyer. And in the air, a place you'd least expect it, a Flying Fortress takes 2,968 lb., a Curtiss P-40, 1,001 lb. The Bell Airacobra, illustrated above in action, used 938 lb. of copper in its construction. And as for ammunition—a single plane such as this, shooting continuously instead of in bursts, could "use up" an additional 280 lb. of copper in sixty seconds of combat.

Turn the page and see the job that Anaconda Copper and its alloys Brass and Bronze are doing in the Aircraft Industry.

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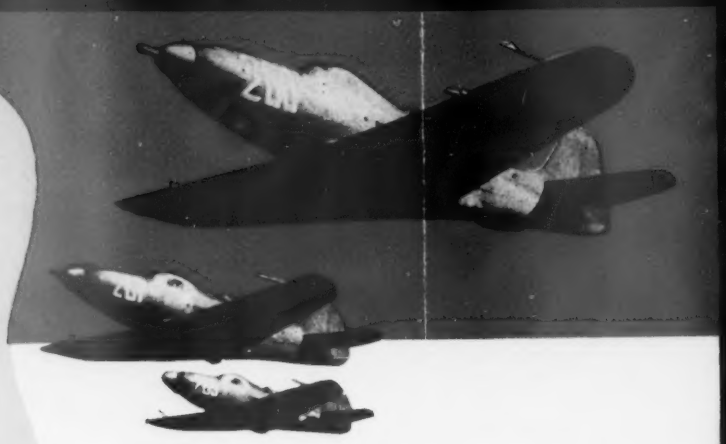
means more flying hours—less work for the ground crew

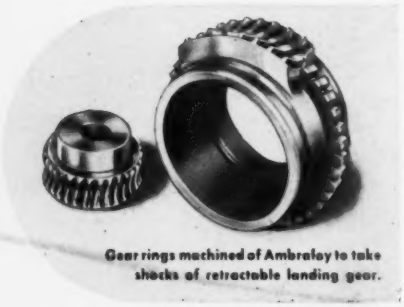


Anaconda Copper Alloys are not newcomers to the Aviation Industry. They played an important part in the engines that made possible the first trans-Atlantic, trans-Pacific and round-the-world flights.

But times and planes have changed, and with them designs for engines, structural equipment and accessories. New standards of aircraft engineering lean heavily on specially developed copper alloys for hundreds of special-purpose applications. Some of these Copper Alloys are briefly described here—each performs its assigned task efficiently and dependably, reducing maintenance and saving priceless man- and plane-hours.

Avialite intake valve seat insert for Pratt & Whitney Aircraft Engines.

AVIALITE* 915: This special aluminum bronze was developed by The American Brass Company for valve seats and guides to withstand the hammering or peening of valves on long, high speed flights. It is also remarkably resistant to pitting by carbon. The coefficient of expansion of Avialite 915 closely corresponds to that of aluminum alloy piston heads, making it an exceptionally suitable material for spark plug bushings. Avialite 915 has been applied to many other aircraft uses including propeller hub cones, gears, bushings and machined parts. One of the foremost builders of aircraft engines uses *85 different parts* made of this Anaconda Alloy.



Gear rings machined of Ambraloy to take shocks of retractable landing gear.

OTHER ALUMINUM BRONZES: Ambraloy 928 and 917 are other aluminum bronzes extensively used for the construction of aircraft and, together with Avialite 915, are the most important copper base alloys used in the aircraft industry. While each has its special application, their outstanding characteristics are: *(1)* Good corrosion resistance, *(2)* high strength, *(3)* resistance to oxidation at elevated temperatures, *(4)* good bearing qualities under certain conditions, *(5)* lighter weight . . . 5% to 10% less than ordinary brasses and bronzes.

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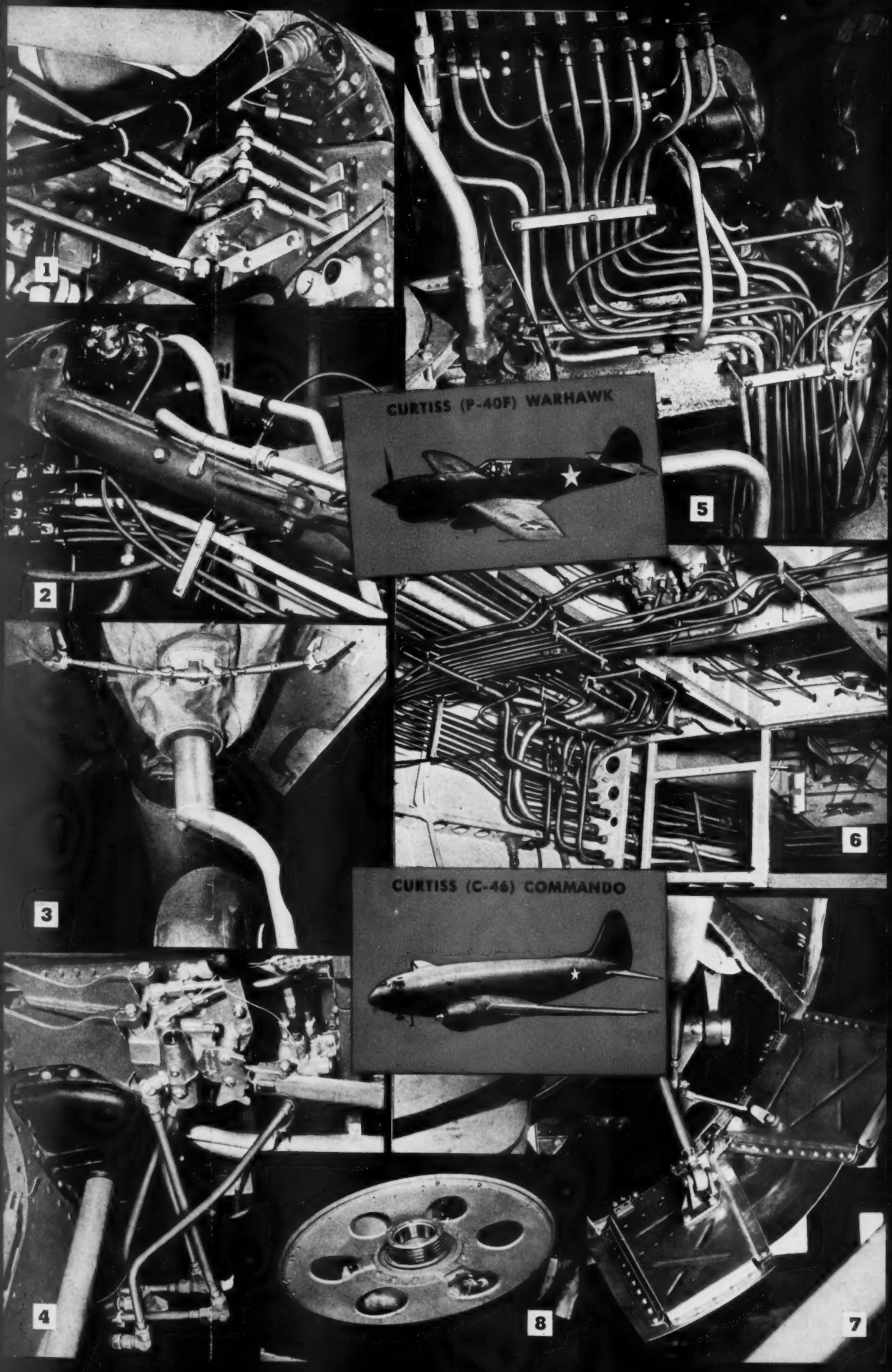
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CURTISS (P-40F) WARHAWK
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CURTISS (C-46) COMMANDO
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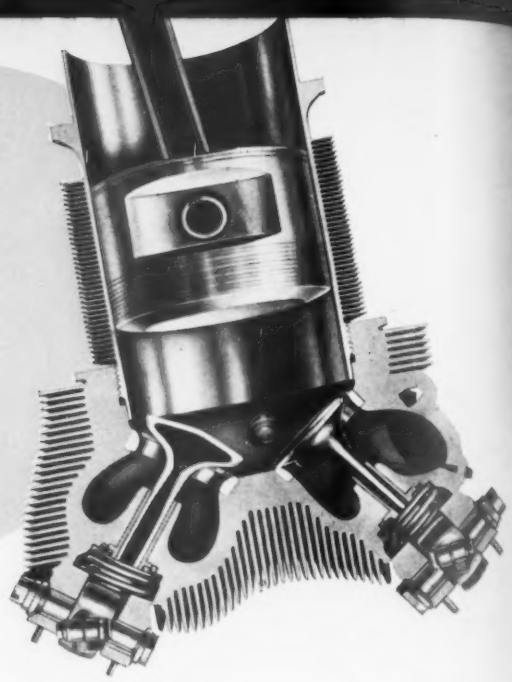
SO MANY PLACES for such a versatile group of Copper Alloys



For maximum performance, Copper Alloys often combine in one material the desirable properties of several metals. Illustrated here are a number of uses of Anaconda Copper Alloys in the Aircraft Industry. Some alloys were chosen for their high tensile strength combined with a high fatigue limit; others for their good spring qualities, hardness and high conductivity; yet others provide good bearing qualities with excellent corrosion resistance. Strong, tough, workable, weldable and machinable, Anaconda Copper Alloys are readily adaptable to the high standards of aviation engineering.

1. In a pursuit ship such as Curtiss-Wright Corporation's P-40, engine controls are doubly important. Tobin Bronze tubing such as pictured provides the necessary strength and resistance to vibration.

2. Flexible Anaconda Copper Tubes convey the gasoline and lubricating oil for the Packard Rolls-Royce P-40 Engine, and filtered air for instrument operation.

3. Corrosion resistant Tobin Bronze turnbuckle barrels operate the doors covering the retractable P-40 tail wheel.

4. Controls in the P-40 cockpit operate landing gear and flaps through hydraulic lines of high strength Everdur tubing.

5. Interesting and intricate is this instrument panel piping arrangement on a Curtiss C-46 Commando. Most of the tubing is Everdur, used for hydraulic lines and automatic pilot controls.

6. Not an oil refinery—just a small portion of the hydraulic tubing necessary for the efficient operation of a C-46. Majority of the lines are made of dependable Everdur.

7. These little hinges on the cowl flap of the P-40 take a beating from vibration—that's why they're made of Avialite. Tobin Bronze is used for the torque tube cowl adjustments.

8. This mysterious-looking mechanism is part of a Curtiss electrically operated variable pitch propeller. Following tests made on numerous metals, Everdur was selected for the contact rings because of its strength and high resistance to fatigue and corrosion.

9. Rugged metals for fighting ships. Many inconspicuous but highly necessary small parts such as these adapters, terminals, and trunnions which are machined from Anaconda Rod and Tube, go into the Bell Aircraft Corporation's famed Airacobra and its equally famous power plant, the Allison Engine.

10. O. K.'d and ready for installation, these Airacobra oil coolers have shells of brass and tubes of copper—the favorite metals for heat transfer equipment.

11. The pilot's oxygen equipment in the nose of the Airacobra comes under the heading of "must be dependable"—hence the use of *Seamless* Flexible Metal Tubing made for many aircraft uses by the American Metal Hose Branch of The American Brass Company.

12. Cylinder assembly of the Jacobs L-4 MBB Engine, built by the Jacobs Aircraft Engine Co., and used to power the AT-17 "Bobcat" and the C-78 light Personnel Transport. Sparkplug bushings are made of Avialite and intake port screw inserts of Everdur Metal.

13. Trim and highly efficient, these fighting Airacobras roll off Bell Aircraft Corporation's assembly lines in almost endless procession.

14. Turnbuckles play an important part in every type of aircraft. They are extensively used in engine controls, wing flaps, landing gear, and for internal strengthening of the fuselage and wings. Pictured here in the wing flaps of the Airacobra, the turnbuckle barrels are made of high strength Tobin Bronze.

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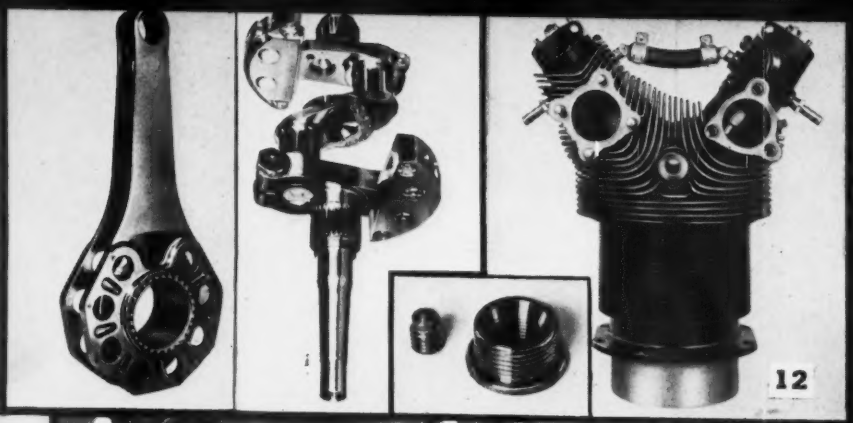
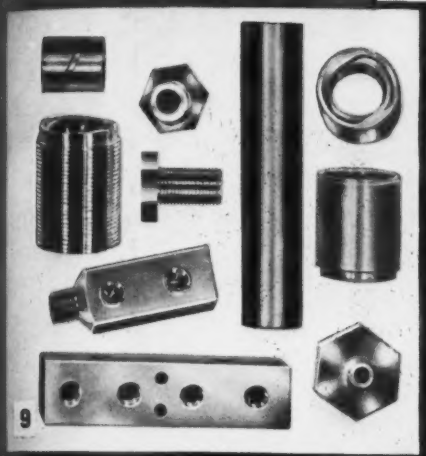
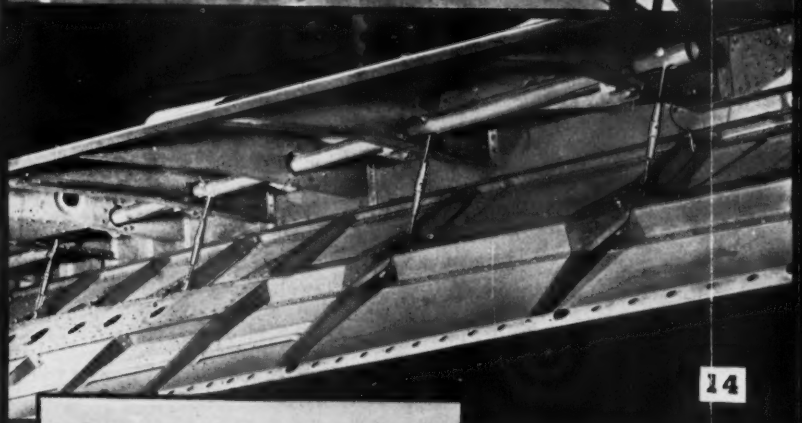
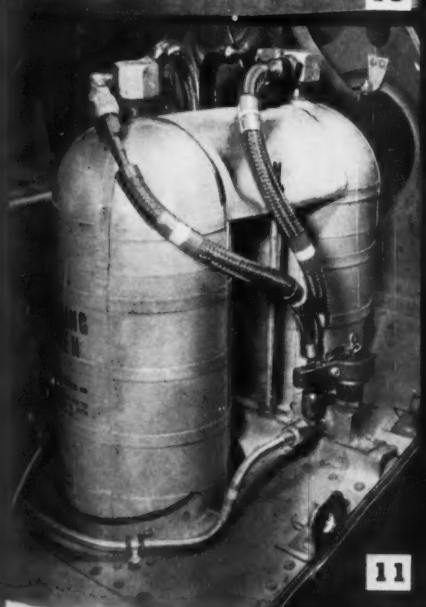
...: Cylin... of a Wright Cyclone ...e, buil... the Wright Aeronauti- ...Corporat... Valve guides, rocker ... bushing, ... spark plug inserts ... made of ...cial Anaconda Alloys.

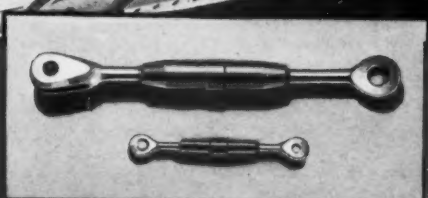
...: The ...er connecting rod of ... engine is ...ushed with bronze and ...al lead-bearing copper alloys. On ... crankshaft of the Cyclone, bronze ... reduce friction between the ...cheek and rapidly oscillating ...







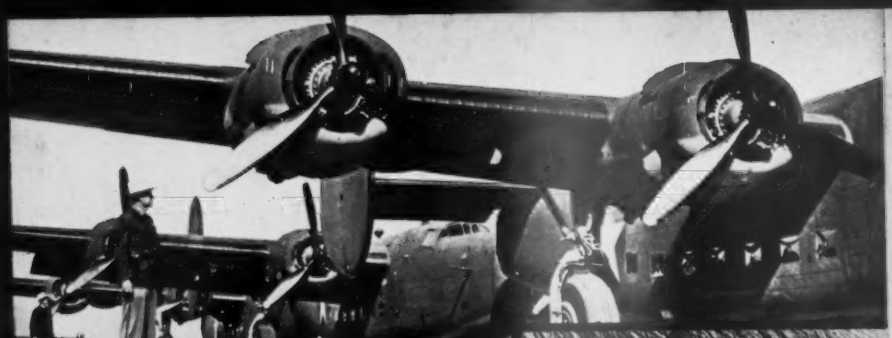


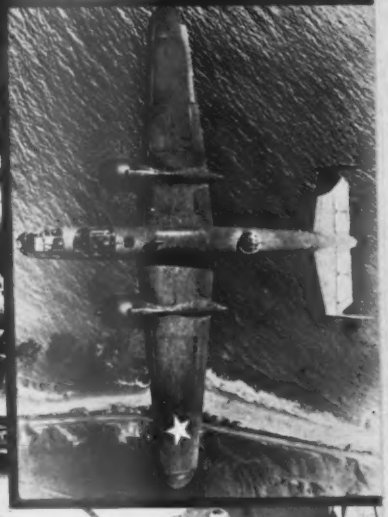


Tons of specially-treated Tobin Bronze are used by the Aero Supply & Manufacturing Company in producing the barrels of aeronautical turnbuckles. As a result of recent cooperation between the engineering departments of the Aero Supply & Manufacturing, and The American Brass Company, tubing of extremely heavy wall was developed to replace the rod stock previously used.

RESULT: A 33% saving both in material and machine time, and an improvement in deliveries of 30 to 60 days.

Made by The American Brass Company





THIS partial list is indicative of the parts, places, equipment and accessories in which Anaconda Metals are used in the Aircraft Industry. Forms include sheet, wire, rod, tubes, special drawn shapes, hot pressed parts and pressure die castings.

●

Spark plugs
Bellows
Radio parts
Condensers
Terminals
Thermostats
Oxygen masks
Battery parts
Electrical instruments
Gunsight parts
Strainers
Meters
Gages
Wire cloth
Tie wire
Water stills
Carburetor parts
Transmitter equipment
Springs
Rivets
Indicators
Generators
Starters
Gears
Hydraulic assemblies
Regulators
Gyroscopes
Drift meters
Lens mounts
Bushings
Bearings
Pump parts
Magnetos
Valve stems
Valve guides
Bolts, nuts, screws
Other fastenings

The foregoing pages illustrate some specific applications of Anaconda Copper, Brass and Bronze as used in the Aircraft Industry. To make the list complete would require a great many more pages. Parts similar to those illustrated—and many others—are incorporated in the construction of the aircraft shown directly above.

Just completed and ready to go, Consolidated Vultee Aircraft Corporation's Liberator Express Transports outside the assembly building.

Double assembly lines in a plant of the Consolidated Vultee Aircraft Corporation. In the foreground are B-24 Liberator Bombers being fitted with "fighting extras." 3025 lb. of copper—in all forms—go into a plane like this. In the background is an assembly line for C-87 Liberator Express Transports, produced exclusively by Consolidated.

North American Aviation's B-25 Mitchell Bomber. It takes 2010 lb. of copper in the form of copper, brass, bronze and special copper alloys to build this plane.

North American Aviation's Fighter, the P-51 Mustang. 681 lb. of copper in all forms are used in building this trim fighting machine.

LEFT: Airspeed Tube component as manufactured by the Dominion Electrical Mfg., Inc. This unique shaped part is an Anaconda Pressure Die Casting.

RIGHT: Tachometer Coupling as used by Pratt & Whitney Aircraft to connect the tachometer drive shaft. Subject to unusual vibration, the metal selected for it was Anaconda Avialite.

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TOBIN BRONZE*: Tobin Bronze was one of the first scientifically developed copper base engineering alloys. This copper-zinc-tin alloy was originated in 1885 by Lt. Tobin, a naval officer seeking an alloy to resist salt water corrosion. Since then, the fabricating technique of The American Brass Company has improved Tobin Bronze so that today it is outstanding as an engineering material. Tobin Bronze is used for airplane turnbuckle barrels (see inside pages), lock nuts, valve stems and many other motor and equipment parts. In the form of wire and rod, Tobin Bronze is widely used for high-strength assembly of iron, steel and copper alloy parts by low-temperature oxy-acetylene welding.

Heavy wall Tobin Bronze tube for aeronautical turnbuckles.

EVERDUR*: Everdur Metal, the original Copper-Silicon alloy, was developed for engineering uses requiring the tensile strength of mild steel, immunity to rust and high resistance to other forms of corrosion. This metal is furnished in four standard alloys; for hot working, cold working, screw machine production, and sand casting. Manufactured to U.S. Army and Navy Specifications, Everdur 1010 tube is being extensively used for high pressure hydraulic control lines, fuel and oil lines. The high strength and high resistance to fatigue of Everdur tube provide especially suitable qualities for this type of application. Contact rings for electrical controls on variable pitch propellers are also made of this versatile material, as are many types of bolts, nuts, screws and other fastenings.

Fastenings of Everdur . . strong, tough, rustless, corrosion resistant.

BERYLLIUM COPPER: For 11 years The American Brass Company has been producing a wrought alloy of copper and beryllium. This metal, Anaconda Beryllium Copper, responds to heat treatment to a far greater degree than any other copper alloy, and possesses physical properties in excess of those of other copper base metals. It has excellent spring properties, high tensile strength and endurance limit, and good electrical conductivity. Because Anaconda Beryllium Copper can be worked and formed in its soft annealed state and then greatly strengthened and hardened by heat treatment, it has many useful applications in instruments, gages, aerial camera parts and other aircraft equipment.

Wright Cyclone Engine parts made of Anaconda Beryllium Copper.

*Trade Mark Reg. U.S. Pat. Off.

"ANACONDA COPPER AND COPPER ALLOYS"

This booklet, PUBLICATION B-28, provides general constants, physical and chemical properties and descriptions of all standard Anaconda Products. A copy will be mailed on request. The inside pages of this insert show where Anaconda Metals are going in the Aircraft Industry—and why.

Anaconda Copper & Copper Alloys

made by THE AMERICAN BRASS COMPANY

ALL AMERICAN BRASS CO. PLANTS IN THE U.S.A. HAVE EARNED THE RIGHT TO FLY ARMY-NAVY "E" FLAGS

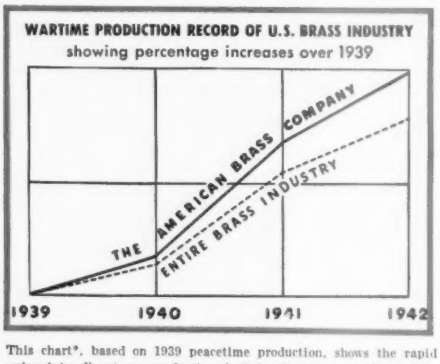
A 100% RECORD

Awards on May 8th, 1943 to two plants in Kenosha, Wis., completed this 100% record for The American Brass Company.

This is the story in terms of war production

Our Connecticut plants were among the first in the brass industry to receive the coveted "E" Award for outstanding production of war materials. Since then *all* our plants, including those in the States of Michigan, Wisconsin and New York, have been similarly honored.

As the largest fabricator in the copper and brass field, The American Brass Company is keenly aware of its responsibility to serve the cause of the United Nations.



This chart*, based on 1939 peacetime production, shows the rapid swing into all-out war production, both by the copper and brass fabricating industry and The American Brass Company (not including Government-owned plants). All-time production records have been continually broken ever since the National Defense Program was initiated in 1940.

*Based on compilations of The American Bureau of Metal Statistics

Since 1939, production has been tripled, with virtually every pound today going for war purposes.

This record was accomplished by close cooperation between management and labor . . . careful planning for rapid conversion to wartime operations . . . intensive training of new personnel . . . plus efficient utilization of existing and new plant equipment.

Detailed figures, of course, cannot be revealed, but The American Brass Company is consistently breaking all previous volume records. In addition to its U.S. plants and that of a Canadian subsidiary, Anaconda American Brass Ltd., the company's production also embraces three plants operated for the United States and Canadian Governments.

Shipments this past January were the largest in the company's history. March exceeded January. The first quarter of '43 was by far the greatest tonnage quarter in the records of the company.

The American Brass Company is proud indeed that all the plants it operates in the U.S.A. have won the honor of flying the Army-Navy "E" for excellence in production. But it is even prouder of the organization and the will-to-produce that have made this record possible . . . *and will keep it going.*

ANACONDA

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut *Offices and Agencies in Principal Cities*

Subsidiary of Anaconda Copper Mining Company

In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

made by THE AMERICAN BRASS COMPANY

plained, and numerical examples of calculation are given. *Aircraft Engineering*, May, 1943, pages 126–129, 3 illus.

Fittings for the Thunderbolt. In numerous places throughout the Republic Thunderbolt fighter plane plastics play major and minor rolls, serving wherever it has been proved that they will save weight, provide strength and make possible rapid, economical production. Cockpit enclosures (except for the windshield) are of transparent methacrylate sheet; name plates are of molded and laminated materials; handles and knobs are made of plastic; some of the pilot seats are of plastic-plywood; laminated and molded units serve as essential insulating equipment in many instances. The cockpit ventilator, which is molded of a high acetyl cellulose acetate, is described in considerable detail. Various fittings made of plastics are illustrated. *Modern Plastics*, June, 1943, pages, 72, 73, 6 illus.

Plastic Developments from Redwood. Harry F. Lewis. An article that describes research work directed toward the production of plastics from the giant redwood trees growing in the Pacific Coast region of the United States. It is stated that lumbering operations result in a high percentage of trees going to waste. The Pacific Lumber Company has been carrying out research on the production of useful materials from this wasted wood. The particular application stressed in this paper is that of redwood plastics. *Mechanical Engineering*, July, 1943, pages 515–517, 2 illus.

Seaplane Floats Go to War. Plastic-bonded plywood floats developed by the Heath Company and now being manufactured for military planes are described. It is explained that the floats are light and inexpensive and that they will be available for civilian planes after the war. An illustration shows how the top skin of the float, which is a single piece of plastic-bonded plywood, is glued to the skeleton in a specially designed jig. *Modern Plastics*, June, 1943, page 84, 2 illus.

Duramold Speeds Stabilizer Production. Herbert Chase. A detailed description of the fabrication sequence in which the Duramold process is applied to the manufacture of stabilizers for Fairchild Primary Trainers. The account includes data on the production and fabrication of components of the stabilizer frame, its assembly, and application of the stabilizer skin, as well as on the method by which the skin is prepared. It is explained how the molding process enables the distribution of weight according to stress pattern and produces smooth shaping of curved-skin surfaces. Other advantages claimed for this method of fabrication are that it eliminates all nailing, requires less time and expense, and results in a stronger, lighter stabilizer. *Aviation*, June, 1943, pages 150–153, 316, 319, 320, 8 illus.

One stage in the manufacture of the Mosquito. Along the full length of the cement fuselage form, rows of steel bands, tightened by turnbuckles, are placed to hold the glue-saturated plywood sheet to shape for at least 5 hours. The bands are perforated to allow the surplus glue to escape and prevent possible hydraulic action which may cause serious wrinkles. After removing these bands the shell is left exposed to the air for several hours before the next operation commences. (See page 177.)

Hydraulics in Transfer Molding. George W. DeBell. In transfer molding, hydraulic flow should not be regarded as merely a means of moving the material from the pot to the cavity. The method of transferring material from the pot to the cavity may have an appreciable bearing on the strength of the ultimate product. The material may be degraded in quantity during transfer. Fundamental principles of hydraulic flow are outlined and the effects of hydraulic flow in transfer molding are discussed. *Modern Plastics*, June, 1943, pages 88, 89, 148, 150, 7 illus.

Points on Plastics in Aircraft Engineering. Part III. John Sasso. The concluding article in a series on the engineering and design of plastic components for aircraft examines the basic principles of molding and the design of plastic parts. Molding processes are placed in two distinct classifications, compression and injection, each of which is briefly described with comments on their advantages and limitations. Compression molding and transfer molding of thermosetting materials are defined, as well as injection molding and compression molding of thermoplastic materials, information being given on the factors upon which the processes depend. The importance of good design is emphasized, and points are made with regard to the tolerances to be maintained. Rules governing fillets are compared with engineering practice as exemplified in metals. Threads and fastening methods are discussed. Tabulated figures cover average thermal expansion and average mold shrinkage and sketches illustrate practices in molded design and fastening methods. *Aviation*, June, 1943, pages 178–180, 356, 358, 359, 361, 3 illus.

Design Suggestions for Molded Phenolics. Mark Maxwell. A description of what molded phenolics are, when they are used, and how they are used. Molded phenolics are used for complicated shapes, for large-production quantities of either simple or complicated shapes, and for certain properties only obtainable in form molding. Typical present-day uses of the material for parts that must possess lightness and strength and stability of dimensions are listed. They include airplane control pulleys, bomb racks, and antenna masts. Information on the great selection and the mechanical and electrical properties of six grades of molded phenolics is tabulated. Charts show the thermal effects on impact on a chopped heavy weave fabric-molded phenolic; a stress-strain curve of a representative grade; and variations of close and commercial tolerance with piece thickness. Illustrations show various features of mold design. *Modern Plastics*, June, 1943, pages 90–93, 132, 134, 136, 13 illus.

Postwar Aviation

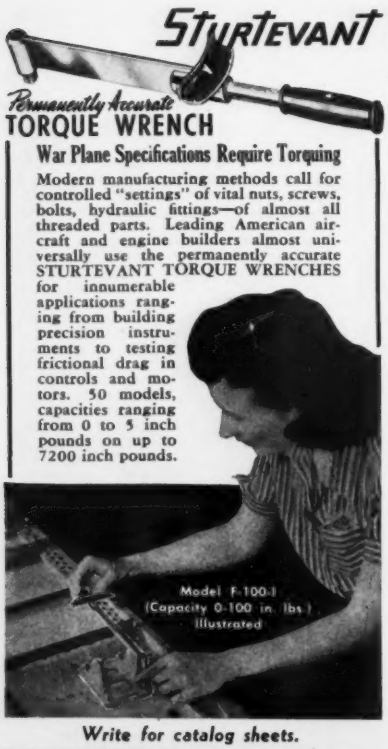
A Postwar Civil Air Patrol. Bill Green. The writer depicts the potentialities for usefulness of the Civil Air Patrol after the war and makes specific recommendations for practical training and equipment which will

help to perpetuate that usefulness. He suggests that during peacetime the C.A.P. can be utilized for forest and pipe-line patrols, antismuggler border patrols, and as an auxiliary to the Coast Guard. In case of postwar compulsory military service, C.A.P. service could be counted as Army service, with annual refresher courses held at various C.A.P. bases. He advocates standardized equipment—radios and guns, as well as "standard C.A.P. airplane models"—to reduce maintenance, repair, operation, and stock problems if there should be another war. With proper arrangements, he states, these "standard C.A.P. models" could be equipped with machine-gun mountings and gearings and with fixtures to which bomb racks could be attached for practice during the military service period or for actual war operation. *Southern Flight*, June, 1943, pages 16, 17, 3 illus.

Wanted—An Air Policy. James R. Custer. Postwar problems confronting aviation companies are discussed and the subject of future air policy is considered. Information on the replies to a set of questions on postwar policy sent to companies in the industry and other interested groups by the Civil Aeronautics Board is included. A joint reply was received from 18 companies and the important points endorsed by them are listed. Significant facts that must be taken into consideration in evaluating the future of American aviation are noted. A considerable amount of statistical data on the subject is given. Trend charts show what progress has recently been made in the major performance and design characteristics of aircraft. These curves represent a correlation of scattered data and were presented at a recent meeting of the Society of Mechanical Engineers by W. W. Davis, United Air Lines research engineer. *Automotive and Aviation Industries*, June 15, 1943, pages 17–19, 138, 140, 10 illus.

Future Equipment of the Airlines. As presented in an address by W. W. Davies to the American Society of Mechanical Engineers, four types of airplanes are envisaged by United Air Lines Postwar Planning Department to encompass the company's postwar services. Supplanting the present all-purpose commercial transport, the suggested airplane types include: a deluxe air Pullman, a flying day coach, a smaller passenger-and-cargo carrier with adjustable bulkhead that would permit the proportionate space between passengers and cargo to be varied, and—dependent upon the volume of the cargo business—a cargo transport capable of carrying 5 tons. Specifications for each of these airplanes are described in detail.

Supplementary tables show the general characteristics of each type of plane. Other tables contain typical trip analyses for the four airplanes. These list the trip length, average speed, average altitudes flown, normal stop times, total elapsed time, and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SETTING THE PACE
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Saving 90% of clamping time—new designs for high speed production work, one hand operation. Non-creep replaceable grips, proof-tested alloy steel construction of forged clamp capacity.
Quikcet 4 second clamp will hold tight even on tapered surfaces without creeping. Fast ratchet rod action under powerful fulcrum leverage. Screws, rods and handles copper plated against welding spatter.
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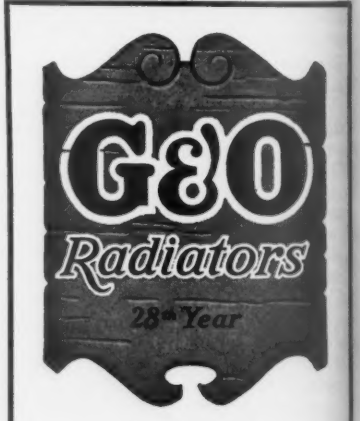

*It's touch-and-***GO** *— to blast Berlin!*

SOUNDS SIMPLE doesn't it? But when our boys are on a mission, dead-instant timing and *immediate* bomb release are required. That split-second when the bombardier's finger flicks the release is all important.

It's got to be *touch*-and-GO—right now!

Heart of this system is the keyboard of release switches. Compact and never-failing, it responds instantly to his touch. A single bomb. A salvo. The entire lethal load. Whatever he wants, precisely when he wants it.

Bomb release switches are made by Boes for one of America's deadliest bombers. The switch was developed to do a specific job—to fit a specific spot in the ship. It had to move into production against an "impossible" schedule yet, when the ships were ready for switches—the switches were ready for ships.

This isn't unusual, of course. In fact, it is typical of the production miracles that spring from the ingenuity, the willingness, and the patriotism of American workers. It is part of the same spirit that impels millions of our people to *build* the tools of war —and to *buy* the tools of war through their purchases of War Bonds.

The W.W. **BOES** *Company, Dayton, Ohio*

MANUFACTURERS OF ELECTRICAL AND NAVIGATIONAL INSTRUMENTS FOR AIRCRAFT

Is there a dollar in your pocket that should be in the fight? Put it in War Bonds today!

Here's FAST, ACCURATE X-RAY INSPECTION of CYLINDRICAL AIRCRAFT ENGINE BEARINGS

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● A fast, accurate routine method of inspecting cylindrical aircraft engine bearings is provided by the G-E Bearing Mandrel Cassette. With this unit the total inspection time required to completely x-ray 20 bearings has been reduced from approximately five hours to about 10 minutes. And in addition to its speed, the unit also provides substantial savings in both film and film-handling costs.

Accurate inspection is assured because the loaded mandrels are rotated 360° by an electric motor drive so that the entire surface of the bearing is exposed to x-radiation during the exposure. Thus the film gives the operator a full view of the uniformity of the internal metal content of the bearing.

The G-E Bearing Mandrel Cassette is but one of several cost-cutting x-ray inspection accessories designed expressly for use by the aircraft industry. Other G-E equipments include a semi-automatic x-ray unit for production line inspection of light metal castings, and x-ray matte transfer units for fast, accurate reproduction of full-scale exact-size templates directly on the material to be fabricated.

Like all other G-E Industrial X-Ray Units they are backed by more than 20 years' experience in the design and construction of industrial x-ray apparatus for all types of applications.

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average cost per ton-mile. *Aero Digest*, June, 1943, pages 145, 315, 316.

The Postwar Air Pulling. William C. White. A series of comments on international rivalry and attitudes about postwar aviation, with Britain and the United States featured as the prime contenders. Among the phases of the subject included in the discussion are: the concern in Britain about the fact that America is conducting most of the current air transport as well as transport-plane production; the competition that may be expected from other nations; the importances of bases; the total abandonment of American isolationism which must accompany the spread of her air lines throughout the world; and the national advantage of a monopoly such as the government-owned British Overseas Airway Corporation. The solution offered for the problem of postwar international air rivalry—the kind that will hinder progress and lead to further conflicts—is a firm and powerful international control and direction over international aviation. *Skyways*, July, 1943, pages 22, 23, 67, 82, 8 illus.

The Military Pilot and Post-War Airplane Sales. Don Valentine. An article on the marketing and servicing of the smaller variety of personally operated airplane after the war. The postwar opportunities for pilots who have been in the service are discussed. The potential market for light airplanes is analyzed, and a typical selling plan is given for a retail sales organization. *Air Facts*, July, 1943, pages 16–22.

Production

De Havilland Mosquito. Wilfred E. Goff. Part I of an article giving an extensive description of production operations employed in the manufacture of what is called the first modern first-line aircraft of all wood construction to go into military service. The de Havilland Mosquito is stated to be the world's fastest aircraft in production. Structurally, the outstanding feature of the aircraft is the fuselage, which is built on the balsa-plywood sandwich principle. The first installment of this article is largely devoted to the construction and assembly of the fuselage and to wing-spar manufacture. The materials and methods are described in considerable detail for building the fuselage, the wing-attachment fittings, the installation of equipment, joining the fuselage, fitting bulkheads, spar manufacture and assembly, and control of the adhesive heating and setting. *Aircraft Production*, June, 1943, pages 262–273, 32 illus.; "Mosquito. . . . . the Fastest Plane in Service in the World Today," *Canadian Aviation*, June, 1943, pages 79–86, 99, 100, 102, 116, 117, 16 illus.; "The de Havilland Mosquito," M. W. Bourdon, *Automotive and Aviation Industries*, June 15, 1943, pages 26–31, 89, 90, 13 illus.; "The de Havilland 'Mosquito,'" *Aero Digest*, June, 1943, pages 227, 229, 232, 340, 341, 4 illus.; "The Mosquito," *Flight*, May 6, 1943, pages 467–470, 471, 472, 472a, 472b, 17 illus.; "The de Havilland Mosquito," *The Aeroplane*, May 7, 1943, pages 532A–539, 17 illus.

Telling the Workers. An account of how the Bristol Aeroplane Company has stimulated production and increased the morale of its personnel through the use of original posters prepared by the company's own studio. The "international publicity" is based on special campaigns for such items as salvage and security, medical services, health, and welfare. All the campaigns are reported to have been effective. *Flight*, May 6, 1943, page 479, 2 illus.

Refrigerating Aluminum Alloy Rivets and Parts. B. J. Fletcher. An article on the use of refrigeration to retard the age hardening of aluminum-alloy rivets and parts. Refrigeration is used to reduce rapidly the temperature of the "as-quenched" metal and to store material until production schedules permit forming. The subject is treated under headings covering the alloys and their heat-treatment, the need for refrigeration, and how various temperatures retard aging. A flow chart for aircraft-rivet chilling and storage is shown. Other charts show the natural aging of 17S and 24S alloys at various temperatures. *Metals and Alloys*, June, 1943, pages 1178–1182, 6 illus.

How Vega Engineering Simplifies Production Methods. Robert A. Trampis and Nels Irwin. The article describes a plan worked out by the works manager and the superintendent of manufacturing engineering of Vega Aircraft to solve the problems arising from major operating difficulties that faced individual foremen. In order to facilitate the handling of these production problems, the Production Engineering Department, which is completely decentralized with respect to shop departments, was established. In each production department a group of production engineers was placed adjacent to the foreman's office. Each of these groups was given full responsibility for carrying on certain activities within the particular foreman's department. *Automotive and Aviation Industries*, June 15, 1943, pages 20, 21, 94, 4 illus.

From Wood to Metal. A British firm, which was in prewar years engaged in architectural joining, is now producing metal aircraft units with woodworking machinery. The manufacture of an auxiliary spar for the Spitfire wing is described. Sections of the article discuss the changeover, hand-forming tools, obtaining interchangeability, and the forming, drilling, and reaming jig. *Aircraft Production*, June, 1943, pages 277–279, 8 illus.

Small-Scale Track Assembly. The application of line- and track-assembly methods to a small workship as carried out by Metalair, Ltd., is described. The shop, which measures 68 by 26 ft., is used for the assembly of Metalair cabin tops. The track equipment is of the most simple and practical nature, and operations have been carefully planned and timed to insure balanced production. There are two short tracks, each carrying three trucks. On one line are assembled the main details. The other is for final assembly and inspection. Joining the ends of the tracks are crossrails which, by means of a movable switch, allow trucks to be transferred to a central rail for return to the other ends of their respective rails. Sections of the article deal with detail assembly, instruction boards, the time cycle, and program indicators. The advantages of the system are summarized. *Aircraft Production*, June, 1943, pages 259–261, 8 illus.

Fully-Automatic Spar Riveter Now in Use at Curtiss-Wright. A description of the automatic multiple riveting machine placed in operation by the Curtiss-Wright Corporation for the handling of 30 and 70 per cent spars used in the manufacture of the Curtiss Commando. With all its positioning and riveting action fully automatic, this riveter is said to effect a 72 per cent saving of time over the method formerly used. Sucessive steps in the operating procedure are related and illustrated by photographs. *Aero Digest*, June, 1943, pages 195, 332, 333, 4 illus.

Mechanized Materials Control Meets Increased Production Schedules. H. U. Zimmer. How the Lycoming Division of the Aviation Corporation mechanized its materials control system when it became apparent that the system then in use would not be adequate to meet increased production schedules. With the new system, tabulating machines quickly provide essential data and enable a rearrangement of methods to meet the stepped-up requirements for hydraulically operated and radial-type aircraft engines. *Wings*, June, 1943, pages 521–524, 4 illus.

Design of Sand Castings for Quality Production. Part 3. N. F. Hindle. The concluding installment of a review of design principles, furnishing information that designers and foundrymen should remember when planning the quantity production of sand castings. The writer discusses cores, dimensional tolerances, the use of metal inserts, and the size of the mold. A summary of basic design rules and conclusions is included. *Metals and Alloys*, June, 1943, pages 1196–1202, 5 illus.

Producing Bomber Castings. Part I. As an example of the successful application of mechanization techniques to small- and medium-quantity production of light-alloy aircraft cast-

CLEAR OBJECTIVE

Rain or Shine

Marquette

All-Weather Windshield Wiper

• 'Round the clock, the bombing of our enemies must continue. In rain and sleet, the Marquette Windshield Wiper provides clear sight for pilot and bombardier, an important factor in the fight to Victory!

The Marquette

METAL PRODUCTS COMPANY

Cleveland • • • • Ohio

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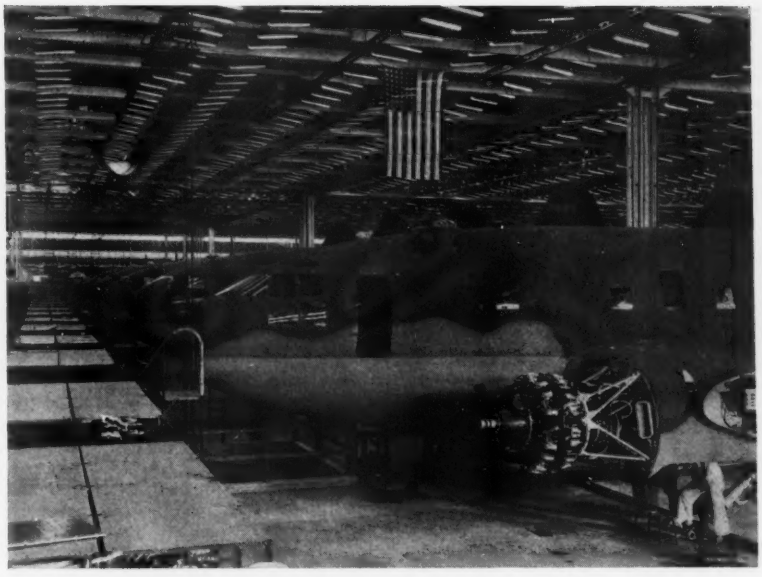
Sixty-Three Parts and Assemblies from Studebaker to Cyclones. Joseph Geschelin. The production of gears and assemblies for the Wright cyclone engine at a plant of the Studebaker Corporation is described. Operations are carried out in a modern single-story, windowless, black-out-type building. Finished gears and assemblies are produced from raw materials received from outside forging shops. Because of peculiarities of form and dimensions and of functional considerations that dictate the choice of materials and their heat-treatment, each individual gear is a unique problem in itself. With few exceptions it was determined that the most efficient method of manufacture would be that of a large-scale job shop rather than a progressive straight-line departmental setup. Consequently, the arrangement of the plant is on a functional basis. The equipment is grouped according to the type of operation, with work routed from one department to another in accordance with the established routing. In the process, each gear is treated individually because of the complexity of annealing, heat-treating, plating, and other steps to which it may be subjected. A feature of the gear planning from the standpoint of metal-cutting practice is the adoption of cemented-carbide tools of special grades for all steel cutting. *Automotive and Aviation Industries*, June 15, 1943, pages 32–35, 67, 68, 70, 11 illus.



Curtiss C-46 Commandos on the final assembly line.

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Quantity production and transportation requirements called for dividing the aircraft into components, thus destroying, to a considerable extent, the advantages of continuity of stressed-skin construction. The jig and tool design problem, practically nonexistent before, sprang up and took on extraordinary importance. Design requirements required to fulfill quantity production needs are listed. Main principles are advanced which should be followed in the design of jigs when the conditions are fulfilled. *Canadian Aviation*, June, 1943, pages 105, 107, 108, 111, 6 illus.

More Air Power Quicker From Conveyor-Assembled Engines. A description is given of how the Studebaker Corporation is using conveyers to speed the assembly of Wright aircraft engines. Roller, floor-chain, wire-mesh belt, and other types of conveyers are used in the plant. Other assembly equipment employed include beam cranes, fork trucks, and special racks for certain parts. Sections of the article discuss the line-production setup, painting, assembly, and final tests. *Wings*, June, 1943, pages 526–529, 8 illus.

Quality Control Keeps Product Standards High. Bert Holland. Demonstrating the value of a systematic means for correcting production discrepancies, the duties and working procedures of the Ryan Aeronautical Company's quality control department are examined. The departmental duties are defined as follows: (1) Investigate the causes of all rejections and employ the necessary measures to eliminate them. (2) Supervise all salvage activities. (3) Point out and take steps to eliminate all unsatisfactory conditions that may become causes for rejections. (4) Cooperate with the production department in the development of more efficient methods to improve quality and avoid rejections. (5) Compile statistics to show financial losses and materials wasted as a result of rejections and poor manufacturing methods. (6) Assist the subcontractors and vendors in developing and maintaining the highest possible degree of efficiency from their inspection departments. (7) Cooperate with the outside production department in determining the qualifications of all subcontractors and other outside sources of supply. (8) Ascertain and advise that department whether or not outside sources are producing products that conform to established standards of quality and workmanship. (9) Deal with customers on problems pertaining to the quality of work being done for them.

Several case histories of error correction are reviewed to illustrate the

CLEAR OBJECTIVE

Rain or Shine

Marquette

All-Weather Windshield Wiper

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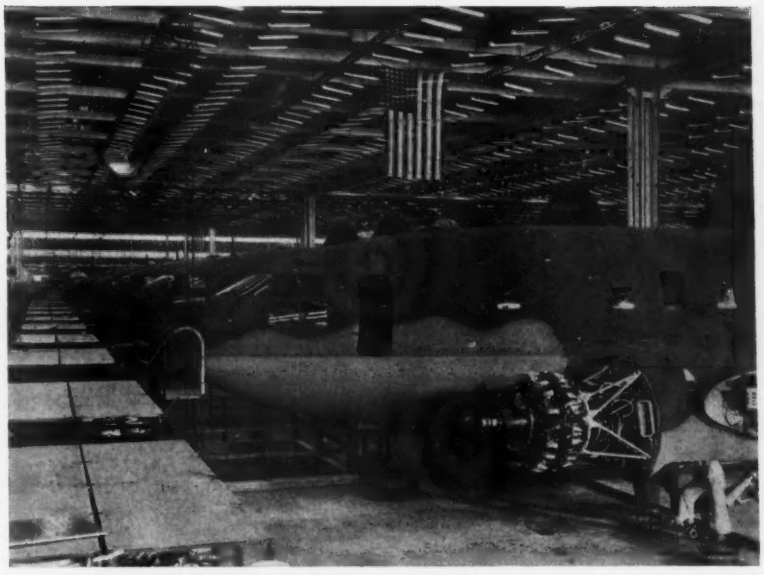

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Several case histories of error correction are reviewed to illustrate the

PRECISION PARTS

4 MORE ACES UP UNCLE SAM'S SLEEVE

Precision-machined, precision-ground on all diameters and threads.

Elevating shafts . . . vertical training shafts . . . screw leveling shafts . . . just so many metal parts to the uninitiated. To the Jap pilot in a Zero, however, they mean anti-aircraft fire too accurate for comfort.

These vital parts of an anti-aircraft gun are typical of the ability of Ace to do fine precision-work on a mass-production basis. The ground tolerances are .0003″ (1/30 the thickness of a human hair) . . . key-ways are held within .0004″ and must be absolutely parallel from end to end and side to side . . . concentricity between diameters is held to less than .0005″ . . . and threads must be ground for the fine accuracy so essential to final assembly and quick replacement.

Today, the demand is for speed, and Ace offers its facilities to other manufacturers on a 24-hour-a-day, 7-day-a-week production basis, embracing: 1. The finest machines in the industry. 2. Managerial know-how for producing parts twice as fine, ten times as fast, as ever before. If you have small parts for stamping, machining, grinding, or assembling, send us a sample, a sketch, or a blue-print for quotation.

This new booklet describes the facilities available at Ace for the machining, assembling and heat treating of small parts. A copy will be gladly sent upon request.

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usefulness of the quality control department, the organization of the department is shown by a chart, and the role of the inspection department in reducing mistakes to a minimum is considered. The writer also explains in detail the discrepancy report system whereby rejections are reported to the quality control office and recommendations are made for corrective measures. The forms that are used for carrying out this work are illustrated. *Aviation*, June, 1943, pages 160–162, 320, 323–325, 327, 3 illus.

Tailoring American Planes to the Job. An article on aircraft modification centers where airplanes from the production lines of American factories are received and equipped to meet the special operating conditions of the countries to which they are to be sent. It is explained that an advantage of these modification centers is that the modification of aircraft for service on different fronts can be made without slowing production lines. Methods and operations used at the modification centers are described and illustrated. *Automotive and Aviation Industries*, July 1, 1943, pages 17–20, 82, 9 illus.

Republic Develops Method for Continuous Milling of Rod Ends. A machine for the continuous milling of rod ends is described. Through adaptation of a special power-driven rotary indexing table to a vertical milling machine, Republic Aircraft Corporation is claimed to have increased the production of rod ends by 1,400 per cent. The table is set up on the miller so that the rod ends are injected into collets that are a part of the table. The vertical miller has three cutters—the center one to make the rod end slots and the other two to form flats. With the machine making a continuous round of operation, the operator merely injects the unfinished rod ends and unloads the completed ones. It is also claimed that much greater accuracy is obtained with this miller than with the horizontal milling machines utilizing gang cutters which it replaced. *Aero Digest*, June, 1943, page 196, 2 illus.

Subcontracting by a Tube Mill. D. E. Lukens. Problems caused by unexpected changes in the requirements of customers, calling for products that the Summerill Tubing Company was not equipped to make, were solved by a combination of conversion of existing equipment and the assembly of a group of subcontractors. The writer shows how these steps were accomplished and explains the changes that were made in machinery and processes to meet the new conditions. He gives instances of the performance of unusual tasks and cites examples of the cooperation rendered by concerns that were enlisted to help in the work. Benefits obtained are mentioned, and incidents are recounted of the difficulties that were overcome. *Aviation*, June, 1943, pages 201, 203, 337, 338, 340, 341, 5 illus.

Impression-Cast Jaws for Aircraft Fittings. A new system of manufacturing aircraft fittings, developed by American Screw Products, is described. It is explained that the company had been following the common practice of machining out of steel the jaws used to hold parts for various machining operations. The practice was slow, expensive, and efficient only with skilled labor. In an effort to comply with the demand for greater production, experiments were conducted with a fusible alloy cast around the forging and subsequently separated into two parts or jaws. The system of making these jaws is said to have revolutionized the machining of forgings in this plant. The particular value of the system lies in its universal adaptation to various types of clamping fixtures, chucks, oversize collets, and vises. *Automotive and Aviation Industries*, July 1, 1943, pages 34–36, 11 illus.

Designing for Production. Part III. James E. Thompson. This is the third of a series of articles on the designing of aircraft parts. It deals with pressure-mold castings, which are made by forcing molten metal under pressure into an accurately machined metal mold or "die," maintaining the pressure until the metal has solidified and then opening the die to remove the casting. It is noted that the process is similar to die casting but produces a casting possessing superior mechanical properties. The method is stated to make possible a high production rate. Machining operations are reduced and thin sections are easily obtained. Manufacturing economies resulting from the use of pressure-mold castings are outlined. Sections of the article deal with basic design construction, fillet and corner radii, the draft angle, finish allowance, and metal inserts in the castings. *Western Flying*, June, 1943, pages 54, 57, 58, 60, 8 illus.

Major Assembly Blueprints. H. V. Almen and R. K. Mead. This article deals with the methods used at a Lockheed factory for classifying and reading blueprints of the major assemblies for airplanes. In general, the company classifies any blueprint used in the fabrication of a major structural unit, together with installation prints used in the fabrication of the airplane, as major assemblies. Because the blueprints of large assemblies, such as a wing or fuselage, are too large for illustration, a description is given of a rudder trimming tab assembly blueprint. *The Draftsman*, June, 1943, pages 9, 10, 33, 34, 1 illus.

Ford Engineers Utilize Steam to Speed Glider Production. An article describing how waste steam, piped through a network of rubber veins, is used to facilitate the production of transport gliders at a Ford plant. The steam is used to produce heat and pressure for glueing operations. With the new system, glueing operations that once took 6 to 8 hours now are finished in less than 10 min. *Contact*, July, 1943, pages 12, 13, 1 illus.

Another Martin First!

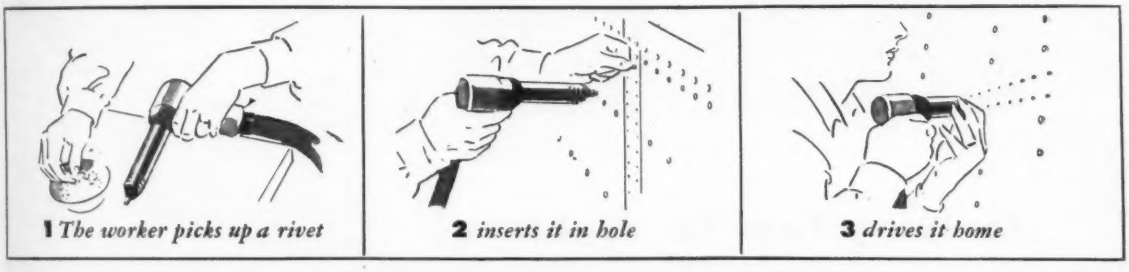
NEW MARTIN RIVET FEEDER CUTS RIVETING TIME 30%!

REDUCING riveting time on aircraft by 30%, this rivet feeder—a new Martin development—changes rivet guns from "single shots" to "automatics." Now undergoing work-tests, the feeder will soon be made available to all industry.

In the form of a magazine, attached to standard rivet guns, the feeder is operated by exhaust air which slides rivets forward, ready for the hole. With one movement of the gun, the worker puts the rivet in place; with another he drives it home. Picking up a rivet and inserting it by hand are eliminated; the worker's hands stay on the rivet gun until a clip is exhausted. Reloading consists merely of dumping rivets through a small door in the feeder.

In the driving of ice-box rivets, faster riveting means less time for rivets to warm up. Since they are untouched by the hand, they are cooler when driven home. The feeder costs nothing to operate, utilizing exhaust air from the rivet gun.

Suggested by a Martin inspector, it's an example of how Martin men and women work together to speed production. And it's an example of the leadership that makes Martin first in the factory . . . first in the air!

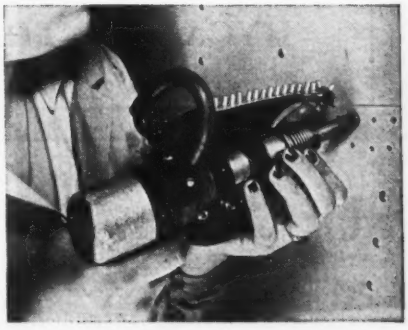


1 *The worker picks up a rivet* **2** *inserts it in hole* **3** *drives it home*

YESTERDAY 3 OPERATIONS

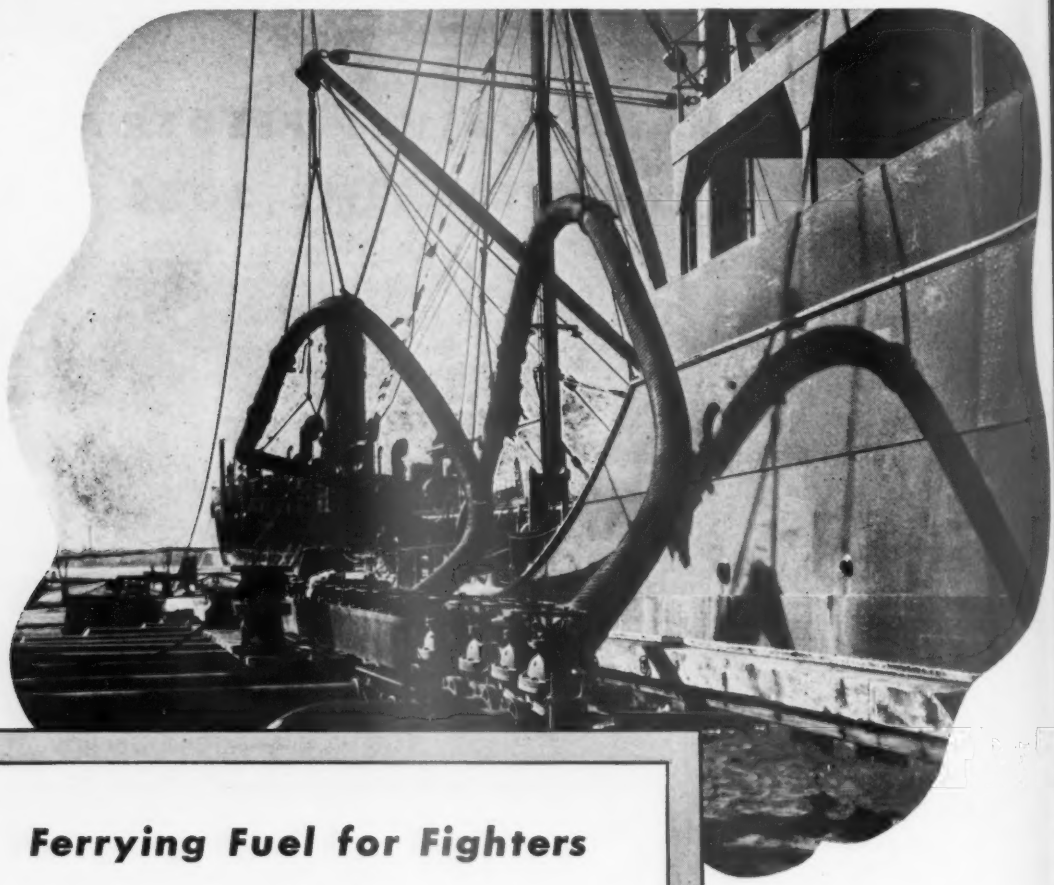
TODAY ONLY 2 OPERATIONS

Lower pictures show how the new device works. (*Left*) Without taking hands from gun, worker inserts rivet waiting at end of the track; (*Right*) drives it home. Results: Thirty per cent speedup in riveting, aviation's tightest bottleneck. *Warplants desiring further information write the Glenn L. Martin Company, Baltimore, Maryland.*



Martin
AIRCRAFT
Builders of Dependable Aircraft Since 1909

400,000 RIVETS hold MARTIN MARAUDERS together even when shot up like this one flying home over Tunisia. The new rivet feeder, by cutting riveting time thirty per cent, will speed victory by speeding output of MARTIN MARAUDERS, BALTIMORES and MARINERS.



Ferrying Fuel for Fighters

...another job for HYCAR SYNTHETIC RUBBER

UP over the side of a tanker go millions of gallons of aircraft fuel—high-octane, perhaps fortified with aromatics, exceedingly destructive to most types of rubber. Yet it's Hycar synthetic rubber hose that ferries this liquid lightning aboard ship at nearly every loading port in the land—Hycar with the same tailor-made resistance to oil, gasoline and other solvents essential to so many aircraft applications.

Hycar oil and fuel hose, coolant hose and hydraulic lines have successfully withstood the acid test—combat duty on the battle-fronts of the world. Its superlative performance under severe service conditions has made Hycar the most widely used of America's oil-resistant butadiene synthetic rubbers.

Extreme resistance to oil, gasoline and aromatic hydrocarbons, heat, abrasion and compression-set, plus low-temperature flexibility and light weight—often saving 20% to 25% over substitute materials—these are the qualities that today limit the use of Hycar to critically important war applications. They are also the qualities that will make it so widely in demand for post-war products. *Hycar Chemical Company, Akron, Ohio.*

Hycar is made in several types, supplied to fabricators in the form of crude synthetic rubber. We will be pleased to work with you and your rubber products supplier in applying Hycar to your problems.

hycar

LARGEST INDEPENDENT PRODUCER OF BUTADIENE SYNTHETIC RUBBER IN AMERICA

Propellers

Problems of Routine Propeller Balancing. Jere T. Farrah. One of the most obvious sources of vibration in an airplane is the engine-propeller combination. For greater passenger and crew comfort plus reduced maintenance, vibration must be kept to a minimum.

All types of vibration equipment depend upon mechanical forced vibrations in some structure, which is caused to vibrate by the engine-propeller combinations. The amplitude of vibration may be determined either electrically or mechanically, and the direction of the unbalance may be determined either by a strobotron, electrically, or by the addition of added unbalance to the various propeller blades.

Propellers are usually balanced upon the airplane but have been successfully balanced several times upon a test stand.

Small factors affect the propeller balance. However, large factors such as the loss of a tip of a propeller have gone unnoticed.

It is recommended that propeller manufacturers should build into the propeller a device for balancing propellers. Propeller balancing equipment should be further developed to be accurate, simple, and easy to use. *Journal of the Aeronautical Sciences*, July, 1943, pages 209–212, 6 illus.

Contraprops. T. B. Martin. Explaining in nontechnical language the operating principles of the Aeroprop dual-rotation propeller, the writer traces the origin of the idea to the Wright Brothers who are credited with having used two propellers of opposite pitch mounted on each side of the engine and driven in opposite directions of rotation by chain drives from the engine crankshaft. After 1930, the growing engine power and greater air speeds focused attention on the dual-rotation propeller. Its use in the Schneider cup races is mentioned, as well as its further development by the British, Dutch, and Americans. The steady progress of the design is recorded and its advantages are summarized under four headings: (1) increase in propeller efficiency; (2) improved take-off and climbing efficiencies; (3) smaller propeller disc diameters and shorter landing gear; and (4) torqueless action. Some of the disadvantages are also summarized, but the advantages are explained at considerable length.

The current type of Aeroprop is described with reference to the coaxial shafts, the blades, and the constant-speed control mechanism. *Flying*, July, 1943, pages 67, 68, 165, 166, 3 illus.

Radio

Vacuum Relay for Aircraft Antenna. Frank S. McCullough. The development of an antenna relay for switching the aircraft antenna from the receiver to the transmitter, in which a vacuum is used for the dielectric, is described. A diagram shows the design of the new relay. It is stated that by pumping the vacuum hard a unit was produced which has overcome many of the disadvantages of previous relays. *Electronic Industries*, May, 1943, pages 79, 80, 2 illus.

United Nations vs. Axis Warplane Radio Equipment. J. I. Waddington. An analysis of some of the qualities of German warplane radio apparatus as compared with equipment manufactured by the United States and Great Britain. Stating that most of the inferiorities of German radios can be attributed to the use of substitute materials, the writer traces the consequences of such substitutions. Weight limitations, which usually characterize substitute materials, are also investigated. It is reported that United States installations for a particular job have as little as half the weight and size of counterpart German radio equipment. *Aero Digest*, June, 1943, pages 154, 155, 333, 5 illus.

Sound Coverage for Airports. Allen A. Sylvane. A description of how the Dilks fluid-flow transmitter is used to deliver sound warnings during air raids. It is explained that instead of using the customary electromagnetic diaphragm, this system utilizes the principle of pressure fluid flow through a device consisting of a rotor and vanes coupled to a horn. The essential differences between the conventional loud-speaker and the new principle is that the older method uses stretched membranes or diaphragms with horns or dynamic cones obtaining their pressure only from low voice energy or "audio-power," whereas the new system derives its increased intensity by the uniform feed of compressed air applied directly into the transforming unit. It is stated that the Dykes fluid-flow transmitter is now being used with success at a certain naval air station. *Electronic Industries*, May, 1943, pages 76–78, 7 illus.

Rotating Wing Aircraft

Sikorsky's Helicopter. Joseph Kastner. A graphic picture of the development of the Sikorsky helicopter is presented in a lengthy article. The aviation industry is said to be taking an interest in the helicopter and the U.S. Army is stated to have placed orders for helicopters with the manufacturer. With the possible exception of a German helicopter, which made a flight inside an auditorium six years ago, Igor Sikorsky's helicopter is stated to be the most successful and practical model yet known and may well become the ordinary citizen's aircraft after the war. A practical description is given in nontechnical language of how the Sikorsky helicopter is designed and operated. A brief outline of the life of the inventor also is given. *Life*, June 21, 1943, pages 80–84, 86, 88, 89–92, 22 illus.

The Mumford Helicopter. Some experiments with a direct-lift aircraft conducted in Britain during the period 1906–1914. Developed according to the ideas of E. R. Mumford, this helicopter employed six lifting airscrews mounted on what is called a flimsy spider framework and was powered by an engine of about 40 hp. and weighing 150 lbs. Direct lift of 40 lbs. per hp. was proved possible with this aircraft. *Flight*, May 27, 1943, page 561, 1 illus.

Stress Analysis

Buckling of Aluminum-Alloy Columns and Plates. Henry L. Langhaar. By means of an argument based on the effective modulus theory, a method has been devised for simultaneously plotting buckling curves for columns and for plates. The usefulness of the method lies in the fact that, with column data only, it permits the estimation of compression buckling stresses for plates with various edge conditions, when these stresses exceed the compression proportional elastic limit of the material. Some composite plate and column curves for 24S aluminum alloy are presented, and a method for applying them to the design of hat-type plate-stringer combinations is proposed. *Journal of the Aeronautical Sciences*, July, 1943, pages 218–222, 9 illus.

Stresses and Displacements in a Rotating Conical Shell. J. L. Meriam. In this paper the writer extends the theory of axially symmetric shells by including the body force of rotation about the axis and applies the results to the rotating conical shell. The analysis follows a pattern established by several investigators and for this reason is abbreviated to a considerable extent. Only where the inclusion of the body force makes elucidation advisable or where a slightly different method of approach is used are the steps presented in greater detail. *Journal of Applied Mechanics*, June, 1943, pages A-53–A-61, 10 illus.

Stressing of Aircraft Wheels and Brakes. H. Burkhardt. Aircraft shock-absorber legs, wheels, and brakes are now such highly stressed members that they deserve special attention. Modern types of wheels and brakes are described in detail, and the theoretic basis for the calculation of the landing process is described in an article that originally appeared in

CHAMPION SPARK PLUGS

C26S—Shielded

provide dependable ignition for the Warner-powered Sikorsky Helicopter now in production for the Army.

C26—Unshielded

Champion Ceramic Aircraft Spark Plugs have, in a relatively short time, compiled an amazingly successful service record. It has been scored principally with the air forces and transport lines, where diversity of engines and operating conditions is the rule rather than the exception.

The exhaustive research, experiments and tests which are back of Champion Ceramic Aircraft Spark Plugs clearly indicated that here at last was a spark plug specifically designed to meet the ignition problems encountered in today's most advanced aircraft engines.

The day in and day out dependability of Champions in bombing, combat, patrol and other wartime duties has gained for them widespread respect and praise. Champions are true champions in fact as well as name.

Outstanding characteristics of Champion Ceramic insulation are

1. Immunity from heat and chemical reactions.
2. Freedom from fuel, oil, or moisture absorption which causes "shorts".
3. Inherently high heat conductivity with consequent wider range between preignition and fouling.
4. Absolute uniformity of material.
5. Homogeneous structure eliminates air spaces which cause current leakage.
6. Easily cleaned and serviced—no specialized equipment or factory returns necessary.
7. Scientifically controlled manufacture.

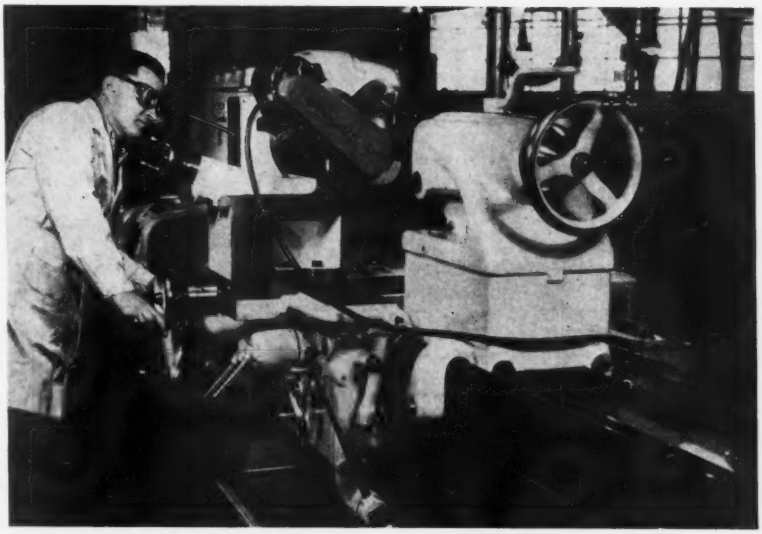
USE CHAMPIONS AND FLY WITH CONFIDENCE

Luftwissen. The essential design requirements that must be fulfilled by aircraft brakes are outlined. Servicing requirements are also given. Because braking power is of particular importance in the design of landing wheels, special attention is paid to braking requirements. The calculation of braking energy and the necessary braking moments is explained. It is noted that modern German aircraft are principally equipped with pressure-oil-operated internal-drum wheel brakes with dual servo-control. The action of the dual servo-brake is explained with the aid of diagrams. *The Journal of The Royal Aeronautical Society*, May, 1943, pages 133–137, 2 illus.

The Center of Shear Again. W. R. Osgood. There is disagreement in the literature as to the location of the center of shear. Timoshenko, for example, states that the position of this point depends upon Poisson's ratio, whereas Trefftz says that it does not. It is explained that both Timoshenko's and Trefftz' solutions are compatible with the usual definition of the center of shear. The writer examines the boundary conditions and proposes a definition of the center of shear that leads to a unique point for any cross section. *Journal of Applied Mechanics*, June, 1943, pages A-62–A-64, 2 illus.

The Influence of the Shape and Rigidity of an Elastic Inclusion on the Transverse Flexure of Thin Plates. Martin Goland. An investigation of the influence of several types of inclusions on the stress distribution in elastic plates under transverse flexure. It is offered to aid in a future study of perforated plates stiffened by means of reinforcing rings fitted into holes. An "inclusion" is defined as a close-fitting plate of some second material cemented into a hole cut in the interior of the elastic plate. Depending upon the properties of the material of which it is composed, the inclusion is described as rigid or elastic. The solutions deal in particular with the effects of circular inclusions of differing degrees of elasticity and rigid inclusions of varying elliptical form. Since the rigid inclusion and the hole are limiting types of elastic inclusions and since the circular shape is a special form of the ellipse, plates with either a circular hole or a circular rigid inclusion are important special cases of this discussion. *Journal of Applied Mechanics*, June, 1943, pages A-69–A-75, 8 illus.

A Photoelastic Study of Bolt and Nut Fastenings. M. Hetényi. An investigation of six different nut designs was made by the three-dimensional "stress freezing" photoelastic method, obtaining the maximum stress values at the bottom of the threads for each design. It was found that by the application of either a tapered-thread nut or a nut with a tapered lip the strength of the fastening can be increased by more than 30 per cent. This improvement in strength can be expected only in cases where the type of loading or conditions of application are conducive to brittle failure—that is, dynamic loads or static loads at elevated temperatures. *Journal of Applied Mechanics*, June, 1943, pages A-93–A-100, 11 illus.



The effect of careful paint selection for various parts of machines under the new "three-dimensional" system developed by du Pont is shown in this picture taken at United Air Lines' central maintenance base at Cheyenne, Wyo. Operational parts of the lathe are painted a "spotlight" buff, safeguards are done in International orange, and the balance of the machine is a horizon gray. Less eye fatigue for the operator, fewer accidents, greater accuracy, and generally increased efficiency are claimed as the results of such painting.

Superchargers

Critical Speeds of a Rotor with Unequal Shaft Flexibilities, Mounted in Bearings of Unequal Flexibility—1. W. R. Foote, H. Poritsky, and J. J. Slade, Jr. A study of the motion of a rotor possessing unequal flexibilities in two mutually perpendicular directions and mounted in bearings that likewise possess different stiffnesses in two mutually perpendicular directions, such as the horizontal and vertical directions. A two-pole turbogenerator is an example of such a rotor. Following an introduction to the general aspects of the subject, the writers proceed with the mathematical analysis, sections of this installment covering the stability and instability of solutions of differential equations with periodic coefficients, the stability near the main critical speed for special cases, the general case of variable shaft and varying flexibility, and the derivation of equations of motion and their solution. *Journal of Applied Mechanics*, June, 1943, pages A-77–A-84, 7 illus.

Testing

Flight Testing Is a Sound Business. Part III. Edmund T. Allen. Based on notes and rough drafts prepared by Eddie Allen, this is the conclusion of a series of three articles on flight testing. It was completed by the famous test pilot's associates at Boeing Aircraft Company.

In this article the procedures employed at Boeing for the execution of test flights at high altitudes are outlined. Details are given on the preparations for the flight, the various phases of the flight itself, manual and photographic recording of data, and the compilation of results and conclusions after the flight. Specialized equipment, the duties of each member of the flight crew, and the number of items which may be tested in one flight are noted. *Aviation*, June, 1943, pages 147, 149, 350, 353–355, 3 illus.

Testing Transparent Plane Sections Under Operating Conditions. An article on the Physics Research Laboratory built by Rohm & Haas for the pretesting of plastic parts of an airplane before they are sent up to high altitudes. This laboratory is designed to duplicate all atmospheric and stratospheric conditions. In it plastic components are subjected to tests of extreme heat and cold, varying pressures, and different weather conditions such as continual sunshine or rain. Other tests that can be conducted in this laboratory are those for determining strength, hardness, elasticity, and other physical properties, as well as bullet-impact tests. *Aero Digest*, June, 1943, pages 295, 299, 7 illus.

Fear. "Witness." Sixth in the series of "Notes from a Test Pilot's

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Diary," this article discusses the practical value of fear to a test pilot as a safeguard against rashness. The variation of fear reactions, differing with each pilot, is noted. The writer also points out the possibility of increasing the usefulness of test pilots by competent medical studies of their neurosis and fear tendencies. *Flight*, May 13, 1943, page 501.

Instruments. "Witness." The seventh installment in "Notes from a Test Pilot's Diary" is concerned with the determination of inaccuracies in oil-pressure gauges and air-speed indicators during ground and flight testing. Indicating several sources of trouble, the writer tells how faults in these instruments are diagnosed. He also suggests that methods for ground testing the complete installation of the air-speed indicator can be improved by employing an electrically driven rig that can provide both pressure and depression equivalent to those met in flight on the pressure and static sides of the pitot. *Flight*, May 20, 1943, page 527.

The Test Pilot's Status. "Witness." In the eighth installment of "Notes from a Test Pilot's Diary" the writer offers his views on the authority and responsibilities that should be delegated to a test pilot. He states that the test pilot should be in the position of an inspector and not a chauffeur. Giving consideration to the qualifications that a test pilot must have to equip him for such a job, he acknowledges certain limitations that sometimes prevent the pilot from functioning in this capacity. It is his suggestion, therefore, that a standard school for test pilots be established which could instruct and grade pupils according to their abilities. *Flight*, May 27, 1943, page 555.

Testing Equipment

Adjustable Orifices for Aircraft Engine Testing. J. P. Green. Adjustable orifices designed to conserve time and labor in the measurement of carburetor airflow are discussed. It is stated that four different styles have been built, including three types of manually operated units and a remote-positioned, air-operated adjustable orifice. The design and application of these devices are described, with information on the conditions each type is intended to meet. In the aircraft-engine testing field, most applications thus far have been for engine test cell installations and for the measurement of air to aircraft carburetor test cells. *Aviation*, June, 1943, pages 175, 176, 3 illus.

The Micro-Hardness Tester. Robert Steinitz. It is stated that with powder metallurgy parts, conventional hardness testing has been generally unsatisfactory because of the porosity or the duplex structure of the metal. This article describes a hardness tester designed for testing such parts. The instrument is also suitable for use in other fields where hardness of localized microscopic areas must be determined. It consists of a diamond penetrator mounted so that it can be attached to a microscope in place of the objective lens. The type of microscope employed has cross hairs in the eyepiece and, by properly aligning the diamond, it can be made to touch the sample under investigation directly in line with the cross hairs. It is only necessary to adjust the microscope so that the intersection of the cross hairs falls over a selected particle of metal powder in a sample. Then the diamond can be made to penetrate this predetermined particle. By this method the actual hardness of the individual particles can be determined. *Metals and Alloys*, June, 1943, pages 1183–1186, 14 illus.

Electric Torque Meters for Aircraft Engines. R. L. Findley. A solution of the problem of using relatively inexpensive electric meters instead of the more costly dynamometer method of measuring aircraft-engine power during standard production tests is described. It is shown that although the recognized cradle-type dynamometer is unsurpassed for the accuracy required in experimental or laboratory work, since it determines the true engine output torque within limits of one-half of 1 per cent, the electric meter method operates within limits of $1^1/_2$ per cent, warranting favorable consideration by engine builders for production tests. The meters and instruments used are described, as well as the procedure involved. *Aero Digest*, June, 1943, pages 285, 291, 339, 3 illus.

Training

Night Flying Training. From a visit to an Oxford-equipped Advanced Flying Unit, the writer describes the night flying training of Royal Air Force student pilots. In addition to outlining the syllabus of night work with twin-engined aircraft preparatory for operational flying, he reports on the various steps of a routine night flight from the Unit's station. *Flight*, May 27, 1943, pages 552, 553; "Nocturne," *The Aeroplane*, May 28, 1943, pages 616, 617, 2 illus.

New A.T.C. Syllabus. An announcement of the postproficiency course which has been introduced into Britain's Air Training Corps syllabus to replace the former Part II proficiency course. It is reported that the new course involves less classroom work and has as its main objective the fitting of air cadets for leadership. The phases of the postproficiency training devoted to air/sea rescue and glider instruction are noted particularly. *Flight*, May 27, 1943, page 563.

Marine Parachutists. Achievements of the U.S. Marines in air actions are described. With the aid of illustrations, the article explains how the Paramarines are trained. *Air News*, June, 1943, pages 27–30, 54, 15 illus.

Singles to Twins. An examination of some of the fundamentals in an R.A.F. student pilot's training when he first learns to fly twin-engined aircraft. In detailing the actual changes and additions in technique that must be taught during this transitory period, the twin-engined airplane discussed is the Airspeed Oxford.

Important differences between flying single- and twin-engined airplanes are outlined, with the considerations including the changed conditions attendant upon the operation of the engines as a pair through the various controls and instruments; changes in visual range due to the pilot's different location in the plane; and reversal of the duties for each hand because the engine and other controls are in the center of the twin-engined plane's cockpit instead of to the left-hand side of the pilot as they are in a single-engined plane. The article notes that cockpit drill, synchronization of engines, and economy in fuel are stressed in flying instruction with the Airspeed Oxford. Among other points covered are the independent operation of the engine controls and the instrument layout of the Oxford. *Flight*, May 27, 1943, pages 549–551, 5 illus.

Mobile Airport Control. James Montagnes. An article on the portable airport control units used by the R.C.A.F. for the training of student pilots. Stationed at the ends of airport runways, these mobile units are employed where nonradio equipped trainers are being used and where students are not always within easy sight of the central control tower. Communications are maintained between planes and the ground tenders by means of light signals. *Flying*, July, 1943, pages 50, 102, 2 illus.

Our Unused Potentialities for Aeronautical Research and Development. John E. Younger. It is believed that the industry of transportation in the air is certain, in time, to dwarf land and water transportation industries. Aviation is in its early stages of development and programs of development which are initiated now will contribute to the aeronautical sciences for many years to come. The writer points out that Federal funds have been provided for practically every phase of aviation except the training of engineers whose business it will be to design and superintend the construction of airplanes of the future. Except the few Guggenheim schools of aeronautics, it is stated that public funds for training aeronautical engi-

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neers are provided mostly by the states through the state universities. The state government cannot be expected to provide the funds for extensive laboratory facilities and the endowment of chairs for teacher-research professors, all necessary to provide adequately for essential scientific engineering training. If additional educational training for the aeronautical engineers who are to be the designers of the future airliners is to be provided for, and this will be absolutely necessary, funds must come from some other source, i.e., personal endowment by the industry or endowment by the Federal Government.

This gap in the nation's aeronautical education and development program is discussed and the requirements for educational progress are outlined. A plea is made for support at present for future aeronautical engineers. The branches of the aeronautical sciences which should be endowed are suggested. *The Draftsman*, June, 1943, pages 25, 26, 42.

Bombing Rattles. Ronald Keith. A dramatic description is given of the methods used to train bomber crews in Canada. Day and night flights that inject realism into the training of air crews are described. A map shows the training-flight route, which runs from the base at London to Goose Lake and up to a section called "enemy territory." *Canadian Aviation*, June, 1943, pages 75–77, 96, 99, 3 illus.

Building Better Bombardiers. The curriculum and purpose of the Army Air Forces Central Instructors School for Bombardiers are outlined. At this school a "postgraduate" course is given to train officer bombardiers as instructors for other bombardiers and to acquaint officers who already are instructors with the most up-to-date training methods. The instruction covers every phase of bombardment, the numerous sciences and mechanisms involved, and extensive training in the specialized field of teaching. Comprising both theory and practical application, the work at the school is rounded out by assigning the graduate to one of several operation training units before he begins his actual teaching.

The fourfold purpose of the Central Instructors School for Bombardiers is outlined as follows: to standardize instruction at all Air Forces bombardier schools; to advance the quality of instruction and administration; to bring the nation's finest instructors to a centralized point where they may pass their knowledge to new instructor personnel; and to establish a "proving ground" for new training methods. *Western Flying*, June, 1943, pages 40, 41, 3 illus.

Ignorance Limited. Gill Robb Wilson. A consideration of mental ability and general education as the foundations of air power. The writer indicates the value of starting air training at an early age, claiming that there is

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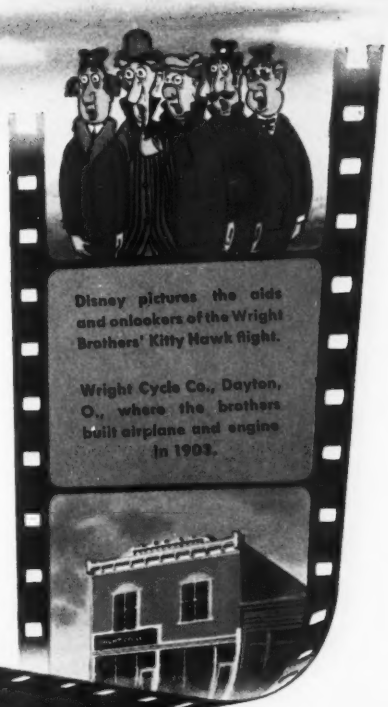

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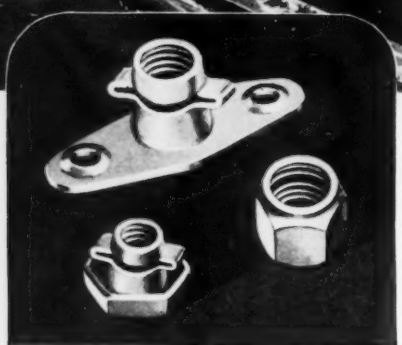

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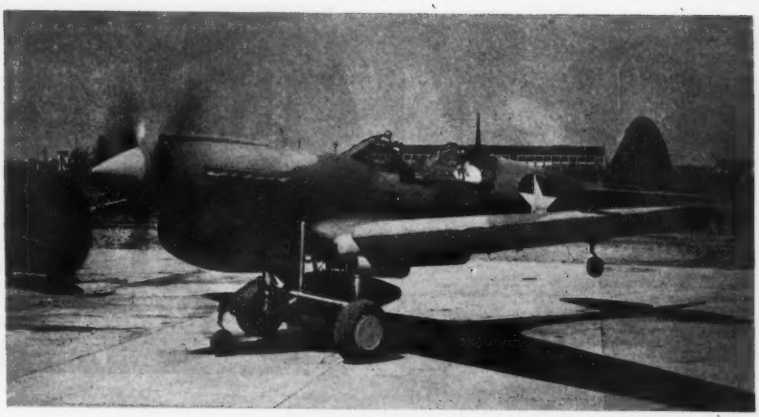
a renewed demand for education that equips the student for the purposes of modern civilization. *Skyways*, July, 1943, pages 16, 17, 59, 62, 8 illus.

The Law of the Roller Coaster. Wolfgang Langewiesche. To provide student pilots with an understanding of how to control a gliding airplane, the gliding plane is compared to a roller coaster, which starts at the top of a slope with little speed and converts altitude into speed as it descends. It is explained that the precise mechanics of acceleration are more complicated, but an understanding of these would not particularly help the pilot, hence they are disregarded. The writer includes information on how to slow down the gliding airplane. *Air Facts*, July, 1943, pages 7-14.

U.S. Pilots—The British Way. Paul G. Sturges. Attendant upon an announcement that a number of American pilots are being trained in British schools is a comparison between British and American pilot-training methods. The British system eliminates the basic course and the basic airplane and calls for transition directly from the primary to the advanced course. British cadets are plunged into a diversified training program almost immediately after soloing in a primary trainer; while under the American system cadets learn only the fundamentals of flying in the primary course, with the more specialized instruction given intensively during the later basic and advanced stages.

In actual flight training, the British place emphasis on steep turns and dives—fundamental to combat maneuvers—while the Americans concentrate on precision flying and learning to make all maneuvers without slipping, skidding, or otherwise changing altitude. Another major difference between the two syllabuses is that British cadets receive more ground-school instruction than do those in American schools. Totaling one-third more in the number of hours, British ground schooling stresses navigation and calls for courses in radio, meteorology, instruments, parachute procedure, general airmanship, aircraft recognition, armament, navigation, and engines. *Flying*, July, 1943, pages 64, 65, 158, 4 illus.

Training in a Miniature Factory. Glynn L. Berg. A description of North American Aviation's factory training unit in Los Angeles. Designed to train unskilled employees for specific mechanical needs, the procedures of this school duplicate those of the actual factory . . . . even to the operation of two eight-hour shifts. The courses cover a three-week training period. Outlined by the article, they include instruction in the following departments: riveting, general assembly, final assembly, sheet metal fabrication, blueprint, electrical assembly, and production control. *Western Flying*, June, 1943, pages 64, 66, 2 illus.



This novel two-place "Taxi Trainer" built from salvaged Curtiss P-40 parts aids in the instruction of Army ground crew men and aircraft mechanics. (See page 177.)

Safety in Flying. Leighton Collins. Flight training and safe flying are discussed. Among the subjects treated are engine failure as a cause of fatalities, loss of control in the air, weather fatalities, structural failures, the emotional factor, and accidents involving a spin out of a turn. Other topics are the rudder-turn complex, angle of attack and nose position, the steep turn, reversal of controls, and induced "pilot error." *Air Facts*, July, 1943, pages 54–82, 10 illus.

Warfare

Tojo's Timetable—. Kilsoo K. Haan. Warning that the bombing of the United States is definitely included among Japan's plans, the writer surveys the factors that favor such strategy and indicate that inevitably the attack will be attempted. He reviews the improvement of Japan's strategic position and the strengthening of her military, naval, and air power. As the only way to forestall such an attack by the Japanese, the writer advises the adoption of an offensive strategy by the United States. *Skyways*, July, 1943, pages 14, 15, 78, 80, 84, 10 illus.

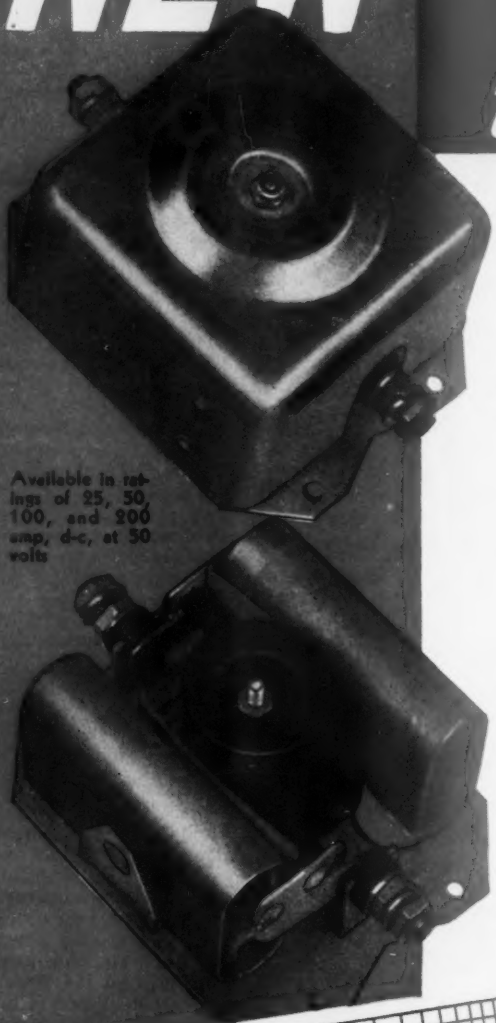
A Fighter Mosquito Squadron. Major F. A. de V. Robertson. Reporting on a visit to a Mosquito-equipped R.A.F. operational squadron, the writer describes the functions of a twin-engined fighter and compares them to those of a single-engined fighter. He explains that the chief purpose of the twin-engined type is offensive and that its long range permits its use deep into the enemy's territory. The article also discusses briefly the role of the second occupant in a Mosquito fighter . . . . that of navigator. *Flight*, May 13, 1943, pages 504, 505, 4 illus.; "A Fighting Mosquito Squadron," *The Aeroplane*, May 21, 1943, pages 588, 589, 4 illus.

Last of the Dive Bomber? Robert McLarren. A criticism of the dive bomber in which the writer summarizes its disadvantages. He points out the uneconomical features of this type of plane as compared with other kinds of air power, calls it the most vulnerable, and claims that it has been replaced by high-altitude precision bombers for strategic missions and low flying and by cannon-equipped fighters for tactical cooperation use. The need of fighter protection for the dive bomber, its inability to protect itself against an adequate force of enemy fighters, and the diminution of its powers of accuracy through increased efficiency in ground defense weapons are called to attention. It is further stated that ground attack, originated and developed by the U.S. Army Air Forces, has in the main absorbed the duties of the dive bomber. *Model Airplane News*, August, 1943, pages 6, 7, 43, 44, 46, 48, 6 illus.

Pilots is Pilots. Clayton Knight. A World War I pilot views the changes between air fighting in this war and the preceding conflict. His comments touch upon comparisons of airplanes, techniques and fighting formations, fire power, radio and ground supervision, "briefing" for air raids, and airdromes. Drawings by the writer, a noted aviation artist, illustrate the article. *Skyways*, July, 1943, pages 28–32, 64, 3 illus.

Where *Are* Mussolini's "White Eagles?" Alexander Kiralfy. Reviewing the record of the Italian air force, this article claims that the unit has been hopelessly inadequate and is now merely an adjunct of the Luftwaffe. It is stated that the Regia Aeronautica has abdicated much of its position as an independent fighting force and that Italy has become a plane reservoir for Germany . . . . with Italian personnel working in German factories and Italian factories filling German orders. Speculative figures are quoted on the numerical strength of the Regia Aeronautica and the aircraft-production capacity of Italy. *Skyways*, July, 1943, pages 42, 43, 2 illus.

NEW G-E RADIO-NOISE FILTERS for Aircraft



Available in ratings of 25, 50, 100, and 200 amp, d-c, at 50 volts

They provide excellent noise suppression —especially from 200 to 20,000 kc

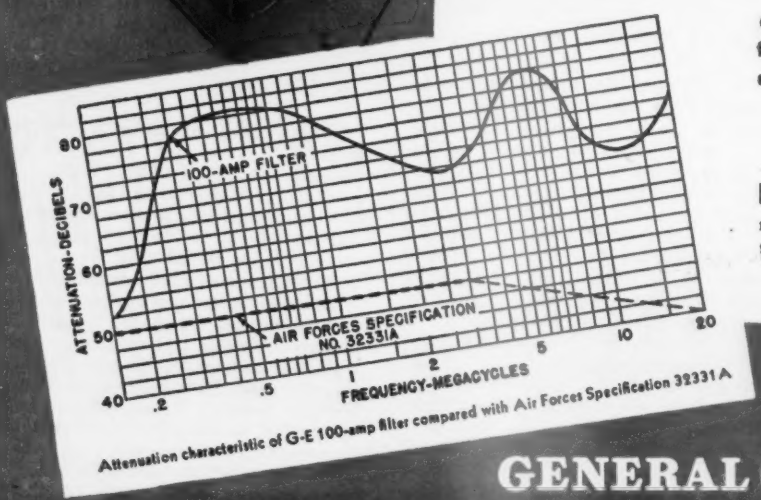
THESE filters help immeasurably in providing the high-fidelity radio reception so important in aerial warfare. They attenuate radio-noise voltage on aircraft electric systems (on circuits with such equipment as generators, amplidynes, inverters, and dynamotors). They are particularly helpful in systems where open wiring is used to save weight.

FEATURES

- **High attenuation characteristic results in excellent noise reduction**
- **Compact and lightweight (For 100-amp rating, shown at left, approx 2 1/5 lb, measuring approx 5 by 4 by 2 1/2 in.)**
- **Can be mounted readily in any position**
- **Operate efficiently over a wide temperature range (—50 C to 50 C)**
- **Comply with U.S. Army Air Forces specifications, including the stringent requirements as to vibration and acceleration**

★ ★ ★

FOR FURTHER DATA Ask your G-E representative for Bulletin GEA-4098, or write to General Electric, Schenectady, New York.



Attenuation characteristic of G-E 100-amp filter compared with Air Forces Specification 32331A

GENERAL ELECTRIC

Welding

Spot Welding in Design and Production of Aircraft. G. S. Mikhalapov. The concluding section of a two-part article discusses the selection of aircraft parts suitable for fabrication by spot welding, setting forth the conditions under which this process is desirable and others under which other methods are preferable. It is stated that certain parts, apparently more suitable for other methods of assembly, can readily be altered in design so as to make the spot-welding process feasible. A comparison is made of the relative costs of spot welding and other methods, and suggestions are advanced for improving the planning of production and control of the work. Better ways for operating and maintaining the welding equipment are outlined, as well as the establishment of standards of inspection. The standards of the American Welding Society are commended and are given credit for a large part in the successful application of spot welding in a large amount of aircraft work. *Canadian Aviation*, June, 1943, pages 111–114, 4 illus.

Silver Brazing and Its Application in War Work. C. M. Robbins. It is stated that the present use of silver brazing is the result of ten years of research. Since the start of the war tons of silver brazing alloys have been used where ounces were required in peacetime. A modern airplane has over 400 brazed parts. Probably the greatest single war use of silver brazing alloys is in the manufacture of bombs and shells. Silver brazing applications are described and illustrated. *The Welding Journal*, June, 1943, pages 410, 411, 11 illus.

AC Resistance Welding Control. Gilbert Sonbergh. In a review of the principles, advantages, and applications of the a.c. resistance method of welding, it is stated that the process has for a long time held promise of becoming the fastest and most economical method for joining metal parts. The progress made by tube-controlled resistance welding in the production of airplanes and other war implements is called an important step. Various basic principles of welding and their methods of control are briefly explained, and a more lengthy explanation is given of the uses of ignitron contractors, electronic weld timers, and pulsation weld timers. The type designations of the National Electrical Manufacturers Association are outlined.

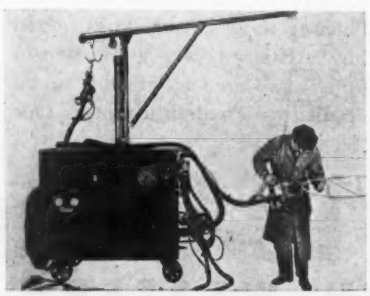
It is stated that for the ultimate in fine adjustment of the current passed through the work, a heat control is incorporated in the ignitron firing circuit. The operation of the phase-shift heat control is described, as well as synchronous control of firing. Several types of sequence timers are listed. *Electronic Industries*, pages 52–55, 152, 153, 9 illus.

Welding in Aircraft Construction. H. O. Klinke. The possible applications of welding in aircraft construction are almost infinite. The application of welding to aircraft construction requires not only a properly trained shop and inspection organization but also a design organization that can think in terms of welded design. Obstacles that may at present be contributing to the relative slowness with which welding has been adopted by aircraft builders are named. It is stated that some of these obstacles are real, as, for example, the training of an organization to use welding properly; some are largely imaginary, as, for example, the repeated question: "How can you be certain that the weld will hold?"

The solution to the real obstacles is to use welding and learn by its utilization. The solution to most of the imaginary obstacles is making the organization weld-minded by the use of men trained in the proper application of basic principles. The writer continues with a discussion of how the Army and Navy could assist aircraft manufacturers. Other subjects discussed are the inspection of raw material and processing, arc-welding application, gas-welding applications, and the spot welding of stainless steel and aluminum. *The Welding Journal*, June, 1943, pages 412–416, 22 illus.

A New Formula for Spot Welding Control of Electrode Tip Diameter. N. A. Tucker. Welding tip diameter must essentially be related to the thickness of the material to be welded, since the tip diameter governs to a large extent the size of the weld and the strength of the joint. The writer reviews the most popular formulas for the establishment of optimum tip diameter for a given thickness of stock to be welded and presents a new formula for spot welding which, it is believed, has never been used as a basis of spot-welding procedure in England. It is stated that a review of the collected figures shows that there is a real need for such a standard acceptable formula.

Tip diameters for various material thicknesses derived from the formulas reviewed and those derived from the suggested formula are given in tabular form for comparison and discussion. It is noted that for extremely heavy sections of material the new formula gives more reasonable figures for the tip diameter than the formulas reviewed. *Sheet Metal Industries*, June, 1943, pages 1051–1053, 1066, 2 illus.



Progressive Welder Company's self-contained cart for spot-welding repairs in the field. (See page 187.)

Proposed Tentative Tests for Metal Arc Weldability of Steels. Suggestions have been made by subcommittees to the Committee on Standard Tests for Welds of the American Welding Society covering tentative tests for the metal arc weldability of steels. The two tests prescribed are a weld-bead hardness test and a tee-bend test, which are intended to determine the weldability of a steel as defined by the effect of the heat cycle which the steel undergoes during the welding process, as evidenced by the change of hardness and loss of ductility of the material.

The weld-bead hardness test is outlined under sections covering the preparation of the test, the preparation of the specimen, the testing of the specimen, results, and the recording of the results. The tee-bend test is outlined under sections covering the preparation of the specimen assembly, the preparation of the specimens, the testing of bend specimens, the testing of the hardness specimen, the results of both tee-bend and hardness tests, and the recording of the results. *The Welding Journal*, June, 1943, pages 433–438, 7 illus.

Jigs and Fixtures for Simple Assemblies. In a paper read at the first technical meeting of the Sheet Metal Industries Association, the writer calls attention to the immense strides in the production of interchangeable sheet metal components made to accurate dimensional limits. Such components call for the design and use of jigs and fixtures which enable all production processes to be adequately fulfilled. To enable jig and fixture construction design to be efficient, a sound knowledge of workshop practice is essential, together with the application of a certain amount of ingenuity and skill. Reference to the lack of suitable nomenclature for detailed processes is made.

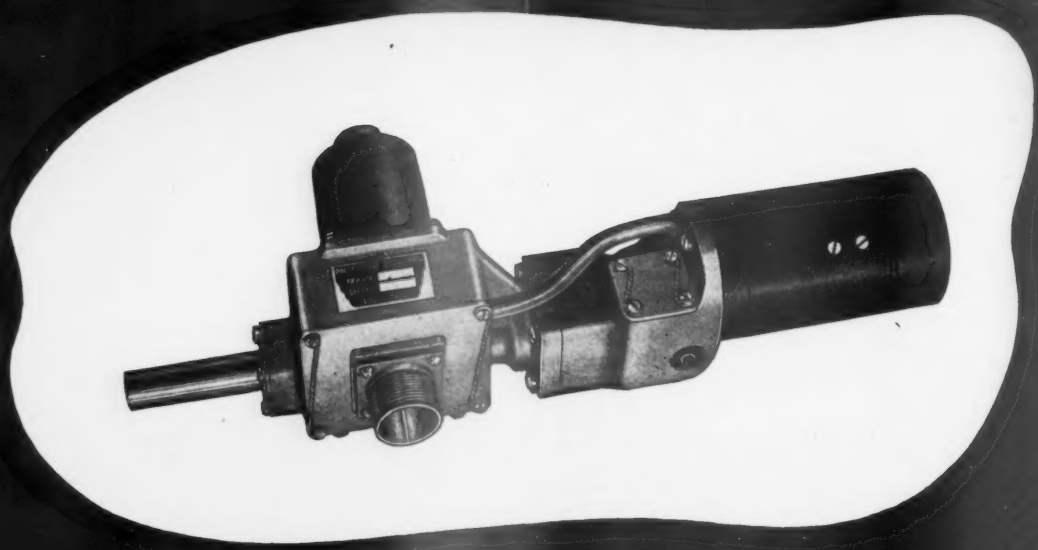
The main advantages of using jigs and fixtures are outlined. Common types of jigs and fixtures in everyday use are described. It is noted that welding fixtures are often much more complex in character than jigs and offer unending scope for the ingenuity of the designer. The design and use of welding fixtures are discussed. *Sheet Metal Industries*, June, 1943, pages 1055–1060, 5 illus.

Miscellaneous

Seventy-Eighth Annual Report of the Council, 1942–1943. The 78th annual report of the Council of The Royal Aeronautical Society gives a

(*Continued on page 167*)

INTRODUCING



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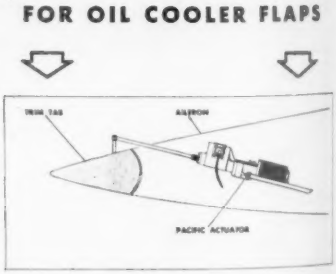
This little fellow makes the Bombardier's shots true

Our new warplanes are rapidly eliminating all manual controls and here is one of the best new units to help in that job.

It is a Pacific Model E-1156 trim tab actuator. At finger-tip controlled button the pilot regulates the action of his ship and keeps it perfectly steady on the bombing run. This small electric actuator takes over the manual task of operating the tab in elevator, aileron or rudder. It provides linear motion of 1½-in. on its shaft and will operate under tension or compression load of 450-lbs. It weighs but 4½-lbs. (approx.)

This is but one of many complete Actuator units built by Pacific Gear Works. Aircraft engineers can find among those already built, tested and flown, units which will handle any auxiliary power application in modern planes. These units are normally powered by altitude tested General Electric motors but can be supplied with hydraulic motors. Our engineers are ready to tackle any problem you bring us.

FOR OIL COOLER FLAPS



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Government Publications

Army Air Forces

Training Commands Consolidated. Activation of the new Army Air Forces Training Command, which replaces and combines the functions of the Technical Training Command and the Flying Training Command, was announced by the War Department.

Major Gen. Barton K. Yount was named Commanding General of the Training Command, headquarters of which were designated at Fort Worth, Tex. General Yount has been Commanding General of the Flying Training Command, with headquarters at Fort Worth. The new assignment for Major Gen. Walter R. Weaver, who has been Commanding General of the Technical Command, with headquarters in Knollwood, N.C., has not been announced. The Flying Training Command and the Technical Training Command were discontinued July 7, 1943.

The reorganization was effected to achieve maximum economy of operation, the most efficient utilization of personnel, and maximum coordination of training schedules and utilization of training facilities.

Functions of the new Training Command will include: supervising and conducting the training of individuals in techniques of aerial gunnery, bombing, navigation, aerial observation, and piloting of military aircraft (including gliders) and in the subjects associated therewith, and in mechanical, technical and administrative subjects; supervising and conducting preliminary training for purposes of orientation, classification, basic military instruction, and preflight academic instruction; operation of the various Army Air Forces' schools of elementary flying, basic flying, advanced flying, and specialized flying; and operation of technical schools to provide technical training peculiar to the Army Air Forces, other than flying training, for both officers and enlisted personnel.

New Wind Tunnel at Wright Field. Designed for testing models of high-altitude bombers and fighters, a funnel-shaped, 10-ft. wind tunnel, which will generate winds of over 600 m.p.h. at temperatures as low as −67°F., is now under construction at the Army Air Forces Matériel Command, Wright Field.

The velocity will be made possible by using two 20,000-hp. motors for the fan drives and by tapering the tunnel from its maximum cross section to a minimum diameter of 10 ft. at the throat where the blasts will reach their highest speed.

Temperature and pressure conditions found at altitudes ranging from sea level to 50,000 ft. will be simulated in the new tunnel. A storage-type refrigeration system will provide the low temperatures.

Supplementing the work of the familiar 20-ft. tunnel now in operation, the new tunnel will permit tests of an entirely different nature. The older 20-ft. tunnel is an atmospheric tunnel, highly valuable in testing aircraft and component parts under simulated sea-level conditions. It was not designed, however, to reproduce altitude pressures or temperatures. The new testing tunnel, built in the shape of a long, narrow rectangle and of the closed-return type, was designed to simulate extremely high altitudes.

Operation at a vacuum of less than one-eighth atmospheric pressure—approximating pressure conditions found at 50,000-ft. altitude—is one of the engineering features of the tunnel. A series of cooling coils will regulate the temperature of the air as it speeds through the tunnel. Refrigeration engineers estimate that the minimum temperature can be held for an hour or more before the cooling process need be repeated.

The newest and fastest of the A.A.F.'s wind tunnels will be constructed of steel plate varying in thickness from $^3/_8$ to $1^1/_4$ in. The two 20,000-hp. motors will drive the counterrotating fans, each of which measures 19 ft. in diameter. The fan blades, made of wood, are being fabricated at Wright Field. Control equipment governing the 20-ft. tunnel will be used for the new project.

Air-Ground Cooperation in North Africa. Brig. Gen. Laurence S. Kuter. The Deputy Commander of the Northwest Africa Tactical Air Force explains the concerted action of the air, ground, and sea forces that contributed to the victorious end of the campaign. The introduction of the tactical air force as a new type of combat unit is credited with an important part in the result. The organization and its work are described. The discussion primarily concerns the air and ground cooperation between the top air unit in the battle area and the top ground unit. It traces the origin of the idea and its development during earlier African campaigns. The organization's efficiency is contrasted with that of the enemy's forces. Functions of the unit and its potential future operations are outlined, with anecdotes covering specific exploits and accomplishments in various battles. Details are given on the action as it developed during the campaign, with information on the planes used. The results are summarized to show the complete success of the system of close teamwork between air forces and ground forces and their commanders. *Air Force*, July, 1943.

Our Pacific Sky-Lane. Major Charles E. Shelton. The origin of the air transport service across the Pacific is traced and its work is compared with that of the North Atlantic and South Atlantic routes operated by the Army Air Forces. Incidents of the establishment of the bases are related, and the growth of the line to an air transport unit of major importance is noted. The types of planes used are mentioned, with comments on their performance. Much of the credit for pioneering the line is given to the civilian pilots, some of whose experiences are recounted. It is stated that many of the airfields in the middle of the ocean compare favorably with numerous metropolitan airports in size and ability to handle traffic. A great increase in transpacific air traffic is predicted after the war. *Air Force*, July, 1943.

Briefing for the South Atlantic Run. Capt. T. W. Finnie. The routine of processing combat crews for the battle fronts through Morrison Field, Fla., is reviewed, particularly the responsibilities of the briefing unit. These duties are to insure that all crew personnel are properly equipped for the flight, including the issuing of route data, maps, navigational equipment, secret codes, and other necessary material and to insure that all flight personnel of departing aircraft are familiar with the facilities and conditions of the route. Information given to the men during the briefing is outlined, as well as the procedure followed in imparting this information. In addition to the verbal instruction, the men receive maps, photographs, and various other kinds of data, all intended to prepare them for safe arrival at their combat locations, ready for foreign duty. *Air Force*, July, 1943.

"Flight Strips," Their Need and Use. A booklet has been issued on the auxiliary landing areas or flight strips

FAMED SKY-DRAGON, North American Aviation's B-25 medium bomber ravages Axis installations as her bombardiers sight their targets through enclosure of "Lucite." The B-25 carries a nosepiece, pilot's enclosure and top and tail turrets of "Lucite."

How Du Pont "LUCITE" serves our WINGS OF WAR

"LUCITE" PERFORMS in the top and side panels of this cockpit canopy. Have you guessed the plane? It's North American's pack of pressed dynamite, the P-51 *Mustang* fighter.

THE NOSE-PIECE of Martin's A-30 *Baltimore* bomber, made entirely of "Lucite," is one of the largest plastic pieces ever produced on mass production scale. Famed for its North African service, especially with the 8th Army, the *Baltimore* carries 21 other transparent parts made from "Lucite."

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"LUCITE" flies to war also with the Douglas *Havoc*, Lockheed *Lightning*, Republic *Thunderbolt*, Curtiss *Warhawk*, Consolidated *Liberator*, Bell *Airacobra* and many more of our foremost war eagles.

CRYSTAL-CLEAR transparent Du Pont "Lucite" methyl methacrylate resin sheeting serves American battleplanes at any altitude, in every climate, all over the world.

Enclosures, as well as other parts made from "Lucite," are light, strong, resilient—dependable in service. Because the sheeting can be formed into wide areas, "Lucite" allows pilots, navigators, gunners and bombardiers maximum vision under all conditions. If damaged by gunfire, "Lucite" sheeting can be repaired simply and effectively.

Here are some of the properties of cast "Lucite" which explain why *America's outstanding acrylic plastic* lends itself so successfully to the needs of military aircraft. Why, too, "Lucite" will prove so important in the building of our post-war world.

Under standard conditions (77° F. 50% R.H.), cast "Lucite" shows...

Tensile Strength—6,000-9,000 psi
Flexural Strength—10,000-14,000 psi
Impact Strength—(Charpy) 0.4-0.6 ft. lbs. per in. of notch;—(Izod) 0.2-0.4 ft. lbs. per in. of notch
Linear Thermal Expansion—(0°-21°C) 7-9 x 10^{-5} per °C
Yield Temperature—(cantilever beam) 80°C
Light Transmission—(visible range, uncorrected for reflection) 90-92%
Dielectric Constant—(10^6 cycles) 2.5-3.0
Specific Gravity—1.18-1.20
Water Absorption—(24 hours' immersion) 0.2-0.3% by weight
Effect of Sunlight—practically none
Effect of Age—practically none

(Many properties are influenced by temperature, stress applied, alignment of molecules in forming and by contour of finished members, which should be compensated for in design.)

• • •

SEE THIS MANUAL FOR MORE DATA

The 114-page Manual on "Lucite," for aircraft designers, engineers, their established enclosure suppliers and for fabricators of plastics, gives detailed information on fabricating, forming, repairing and general properties of "Lucite." Get your *free* copy. Write on your business letterhead to: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N. J., or 5801 So. Broadway, Los Angeles 3, Calif.

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methyl methacrylate resin

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

that supplement the air base and airport programs of the Army. The need for flight strips is discussed. The booklet describes how flight strips support air bases and how they help to control the air, fight submarines, and increase the efficiency of air routes. Diagrams and illustrations clarify the explanations.

National Advisory Committee for Aeronautics

Researches on Preliminary Chemical Reactions in Spark-Ignition Engines. E. Muhlner. Translation of an article from *Luftfahrtforschung*, Vol. 19, No. 18, August 20, 1942. Chemical reactions can demonstrably occur in a fuel-air mixture compressed in the working cylinder of an Otto-cycle (spark-ignition) internal-combustion engine even before the charge is ignited by the flame proceeding from the sparking plug. These are the so-called "preliminary reactions" ("preflame" combustion or oxidation), and an exact knowledge of their characteristic development is of great importance for a correct appreciation of the phenomena of engine-knock (detonation) and, consequently, for its avoidance. Such reactions can be studied either in a working engine cylinder or in a combustion bomb. The first method necessitates a complicated experimental technique, while the second has the disadvantage of enabling only a single reaction to be studied at one time. Consequently, a new series of experiments was inaugurated, conducted in a motored (externally driven) experimental engine of mixture-compression type, without ignition, the resulting preliminary reactions being detectable and measurable thermometrically. *N.A.C.A. T.M. No. 1049*, June, 1943.

Civil Aeronautics Administration

With the cooperation of the War Training Service, the Aircraft Engineering Division has completed a survey of engine difficulties that are being encountered in connection with the use of currently available leaded 73- and 80-octane aviation fuels in low-powered aircraft. The results of this survey indicate that specified remedial measures and recommended procedures may be utilized to advantage in counteracting the difficulties indicated.

The results of the survey further indicate that these difficulties are quite widespread and have been reflected in considerably increased maintenance and particularly in more frequent top overhauls. This situation is for the most part due to the fact that most low-powered aircraft engines were originally developed with the then available clear (unleaded) fuels. The use of the leaded low-octane aviation fuels has been necessitated by the present war emergency.

Instructions are detailed, under the following headings, for overcoming the

listed difficulties: (1) to preclude sticking valves; (2) to preclude spark plug fouling; (3) to preclude overheating and detonation; (4) to preclude piston ring sticking; (5) to preclude corrosion; (6) general precautions. *Safety Regulation Release No. 148*, June, 1943.

Navy Department

A June supplement to the index of Army-Navy aeronautical standards, including aeronautical specifications, drawings and bulletins, has been issued. The supplement contains all new Army-Navy aeronautical standards issued since May 1, 1943.

In addition to the index, 15 new heets on Army-Navy aeronautical standards have been issued, 14 sheets on Army-Navy aeronautical design standards, and in addition one Naval Aircraft Factory sheet on an aviators' four-piece helmet. *Bureau of Aeronautics.*

Office of War Information

A report of the activities of more than 75,000 volunteer airmen of the Civil Air Patrol who operate out of United States airfields has been issued. The report outlines how the Civil Air Patrol was organized and expanded and describes its many duties and how they are being performed.

British Information Services

The Campaign in Greece and Crete. A book of 64 pages contains an account of the British campaign in Greece and Crete up to the time when the Greek mainland was evacuated. The author explains why the Greek campaign was started, discussing Greek morale versus the German menace and describing the arrival of the Imperial forces in Greece and how the opposing armies came to grips. Crucial battles are discussed and the story of the Greek evacuation is told. The latter part of the book is devoted to the battle of Crete.

Roof Over Britain. An official account of Great Britain's antiaircraft defenses, which represents part of the story of how the German air force was defeated in the autumn of 1940, is presented. It deals with the antiaircraft guns, searchlights, balloons, and the Royal Observer Corps constituting Britain's static defenses. The speed with which these defenses were developed is described. How members of the Royal Observers Corps live and work is outlined. Sections of the book cover the first winter, what the guns really do, searchlights in action, the blitzes on the Humber, defending the airfields, the great London barrage, how Portsmouth fought back, antiaircraft women, and balloons in battle.

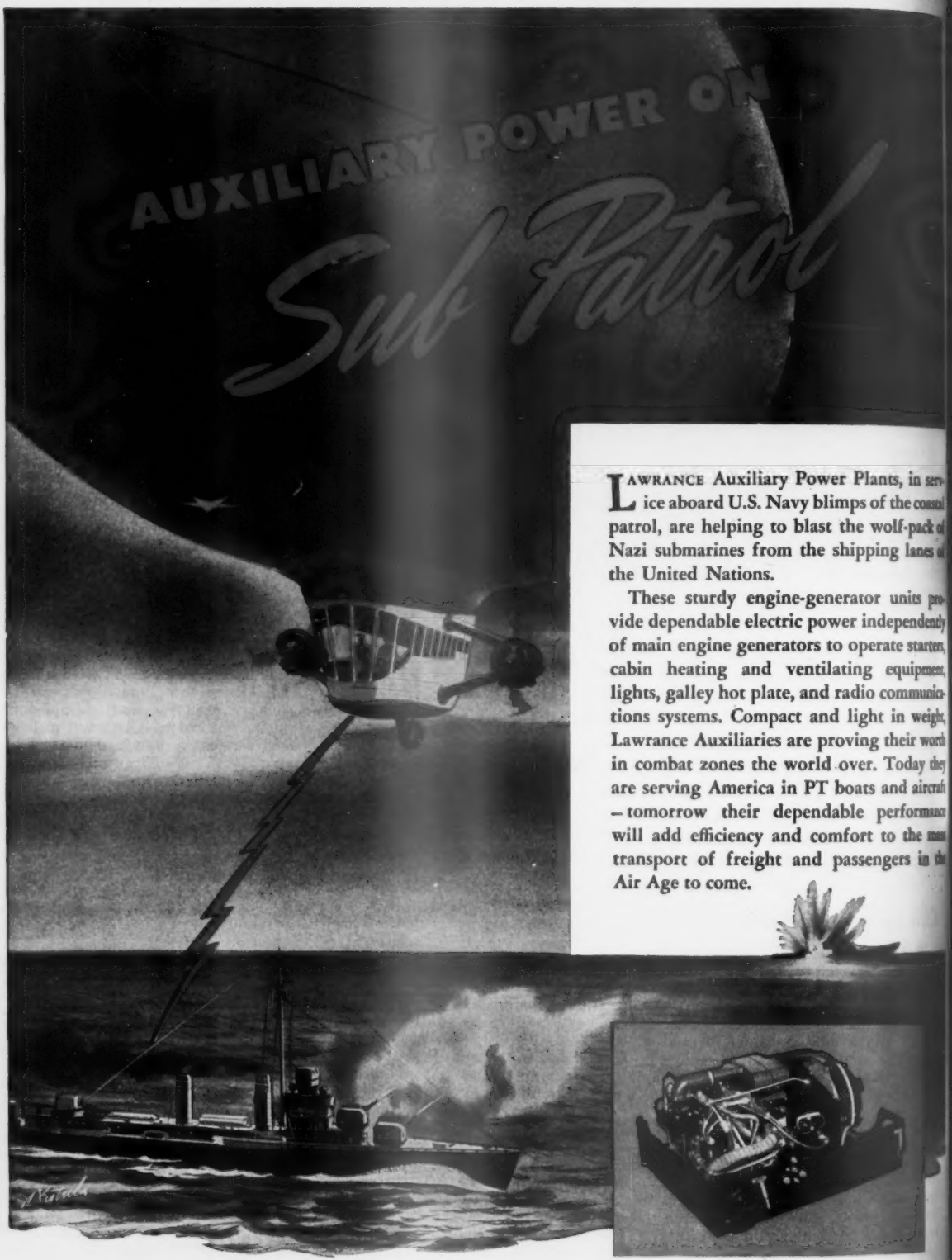
Combined Operations. Exploits of the British Operations Command and an account of combined operations in general are given in a new booklet. It is explained that a combined operation is one in which two or more of the fighting services cooperate in order to strike the enemy with the maximum of effect at a chosen place and at a chosen moment. The book describes the organization, training, and activities of the Operations Command.

His Majesty's Minesweepers. Information on minesweepers of the British navy is furnished in an official booklet. How the minesweepers have won a four-year battle with the enemy is described. A brief outline of the development of minesweeping is given, and minesweeping operations in the different theaters of the war are described.

Destruction of an Army. A new pamphlet on Great Britain's first campaign in Libya covers the period from September, 1940, to February, 1941. The Libyan campaign, which is stated to have been the first example of a desert war between two full mechanized armies, is described in considerable detail. Illustrations and maps aid the reader in understanding and visualizing the military operations.

East of Malta, West of Suez. A booklet has been issued containing the British Admiralty account of the naval war in the eastern Mediterranean. It describes the work of the British navy in this area from the outbreak of the war until the spring of 1941, by which time British supremacy in these waters had been vigorously asserted at Taranto and Matapan. It is stated that, if during those 18 months the British navy had not been successful in maintaining its control of the eastern basin against greatly superior forces, Malta, Suez, and Alexandria might have fallen, the campaign in Abyssinia and Syria would hardly have been possible, the whole Middle Eastern position would have been endangered, and the Axis might have reached the Indian Ocean from the west.

Instruction Films. How students of a Royal Air Force school are being taught new techniques in gunnery tactics with the aid of films of planes in actual combat is described. It is explained that the pictures are made by tiny cameras that are set in the starboard wings of the majority of Britain's fighter planes. The camera is set in motion when the plane's guns open fire and takes 16 pictures per second.



LAWRANCE Auxiliary Power Plants, in service aboard U.S. Navy blimps of the coastal patrol, are helping to blast the wolf-pack of Nazi submarines from the shipping lanes of the United Nations.

These sturdy engine-generator units provide dependable electric power independently of main engine generators to operate starter, cabin heating and ventilating equipment, lights, galley hot plate, and radio communications systems. Compact and light in weight, Lawrance Auxiliaries are proving their worth in combat zones the world over. Today they are serving America in PT boats and aircraft—tomorrow their dependable performance will add efficiency and comfort to the mass transport of freight and passengers in the Air Age to come.

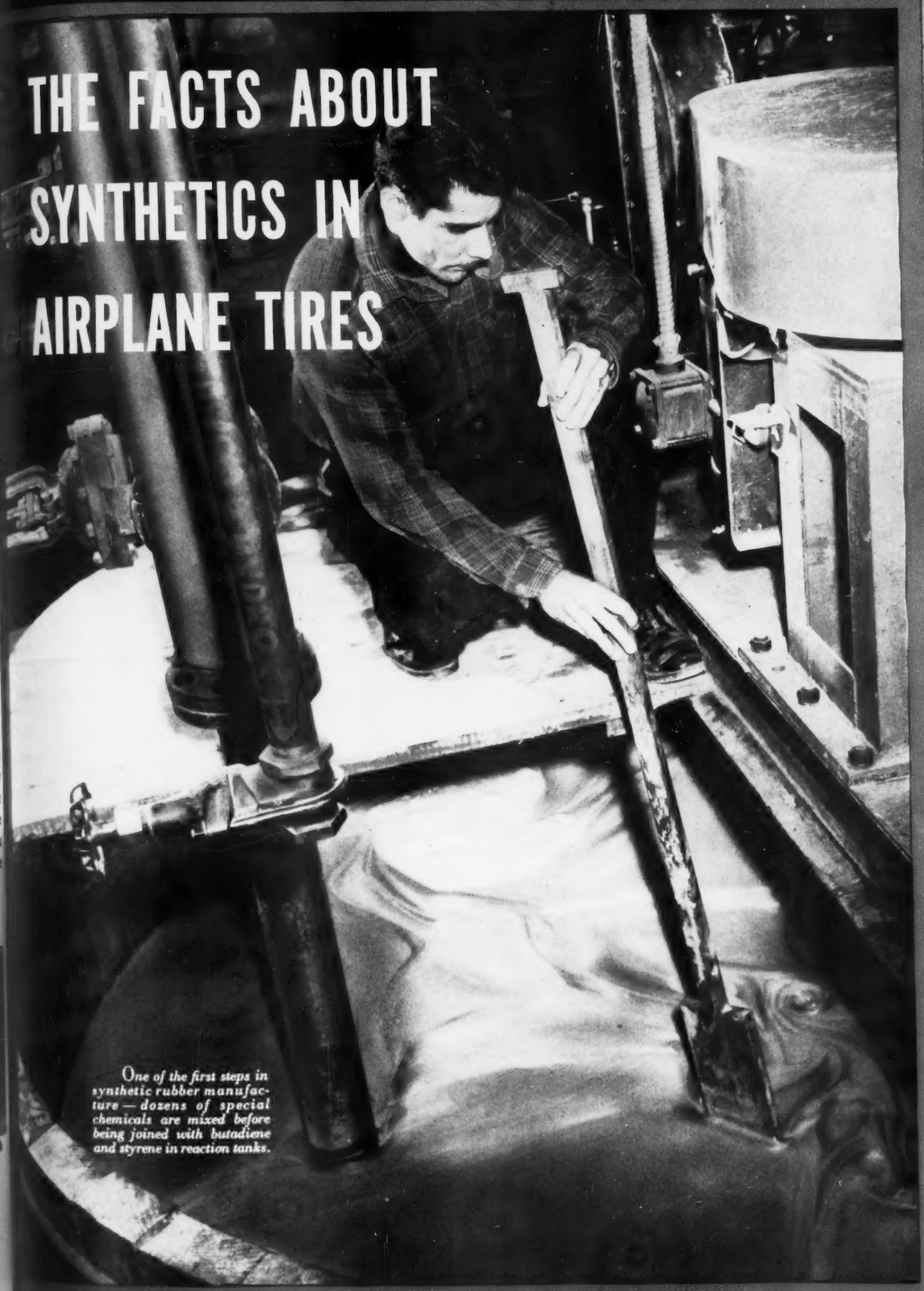
LAWRANCE POWER

Lawrance
AUXILIARY POWER

Lawrance Auxiliary Power Plant
Model 30C-2
Length 33 5/16"; Width 26½"; Height 17 1/16".
Total Weight of Complete Unit 213.0 lbs.
Maximum Continuous Power Rating 5KW.

LAWRANCE ENGINEERING AND RESEARCH CORPORATION • LINDEN, NEW JERSEY

THE FACTS ABOUT SYNTHETICS IN AIRPLANE TIRES



One of the first steps in synthetic rubber manufacture — dozens of special chemicals are mixed before being joined with butadiene and styrene in reaction tanks.

UNITED STATES RUBBER COMPANY

The Facts About

SYNTHETICS IN AIRPLANE TIRE CONSTRUCTION

How "U.S." Blended Synthetic Rubber and Synthetic Fibre—and Made Stronger Tires!

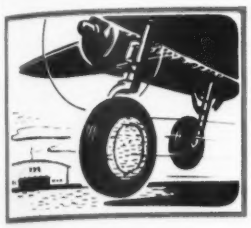
Like the famous sulfa-drugs that are performing miracles of healing on the battlefield and on the sick bed, and yet whose full possibilities may not even have been touched, synthetics, both rubber and fibre, are proving new and greater uses every day. This is one field to which the technical men of the United States Rubber Company have applied their skill—to discover how synthetics can best be used in the products of the rubber industry. In their minds there have been no preconceived ideas, no "pet synthetics." There has been only one objective—to produce the best products that can be built.

"Know how" in synthetic rubber has run in the "U.S." rubber family from the early days back in 1921 when "U.S." chemists began their first synthetic rubber research. It was this "know how" that made it possible for the company to contribute to the improvement of the process of manufacture of GR-S (the Government synthetic now being manufactured by a number of rubber companies) so that 15,000 tons per year could be turned out without extra men or equipment in plants designed to produce only 10,000 tons per year. This "know how," too, showed the industry how to make GR-S 80 to 90% as workable as natural rubber instead of only 45% or 55% as before.

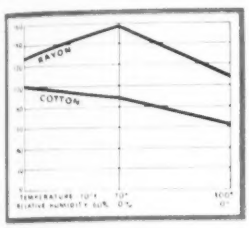
UNITED STATES RU

Listen to the New York Philharmonic Symphony broadcast over Columbia network every Sunday afternoon 3:00 to 4:30 P. M. Eastern War Time.

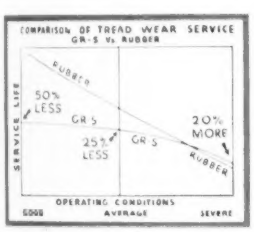
1230 Sixth



In January, 1942, working with the Army Air Corps, "U.S." developed a synthetic airplane tire. Test after test proved that this synthetic tire was equal and in some ways superior to the best natural rubber airplane tire made. The rigid standards of the Air Force were satisfied and deliveries of substantial quantities of synthetic tires against Army Air Corps orders started rolling out of United States Rubber Company plants in March, 1942. Today, synthetic tires for airplanes and for military vehicles of many kinds are the order of the day.



"U.S." technical men found that to be most efficient, an airplane tire built with a synthetic rubber tread should also have a synthetic cord body. In a blend of synthetics, both rubber and fibre, seems to lie the sturdiest, toughest, longest-wearing tire. The reason is simple. Synthetic rubber develops more heat on flexing than natural rubber does. The thinner rayon carcass minimizes the development of that heat. Also, rayon is superior to cotton because, when the tire gets hot, the strength of rayon does not decrease as much as the strength of cotton. The result is an airplane tire that under certain conditions can outperform tires made from natural rubber and cotton.



As a result of tests in the "U.S." laboratories and in actual service, another startling fact was discovered. Although in most of the physical characteristics which affect tire performance, GR-S is inferior to natural rubber, it was definitely proved that when landing conditions are toughest, loads heaviest, airplane tires made from synthetic rubber treads and synthetic cord bodies could "take it" after the natural rubber and cotton cord tires had failed. This superiority of synthetic over natural rubber *may* well lead to new and greater uses of synthetic.

Synthetics in airplane tires do not mean just synthetic rubber. They also include rayon and Nylon which in their fields seem to hold as great a future. The experience piled up by "U.S." in pioneering rayon airplane tires, which are now the standard of the services, has contributed greatly to the development of today's improved synthetic airplane tire. Where this combination of synthetic materials may lead is still unknown, but whether made from Nylon, from rayon, from cotton cords, or from spider-web thin steel, from synthetic rubber or from the natural milk of the rubber tree, "U.S." will build better and better tires—as its technical men open up new methods and materials to the America of tomorrow.

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U. S. Royal Airplane Tires and Tubes Have Five Important "Extras"

1. **TEMPERED RUBBER TREAD** — A tougher, scuff- and heat-resistant tread compound for airplane tires.
2. **SAFETY-BONDED RAYON CORD** —A lighter, more resilient, airplane tire material with tremendous impact resistance and stamina at high temperatures.
3. **FIELD AIRPLANE TIRE SERVICE** —A force of "U. S." field engineers in every part of the country is promptly available for engineering and technical help on tire and undercarriage problems.
4. **"U. S." ICE GRIP TREAD** — a tread of revolutionary design and performance for snow- and ice-covered landing surfaces.
5. **STATIC GROUND CONSTRUCTION** —Conductive rubber construction grounds static electrical charges upon contact with the ground. This safety feature is available in every U. S. Royal Airplane Tire.

Your Copy of this Airplane Tire "BOOK-OF-THE-YEAR" *Is Ready!*

— WRITE FOR IT TODAY

Just off the press, this 62-page book contains the latest technical data and engineering information on landing wheel, tail wheel and beaching gear tires and tubes. A series of 33 Load-Deflection Curves show at a glance percentage deflection and deflection in inches at varying loads and pressures. A request on your firm letterhead will bring your copy without charge.

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How Our Army Grew Wings

The late Col. Charles deForest Chandler and Brig. Gen. Frank P. Lahm, Retired

Chapters: Early Aeronautics; Civil War Observation Balloons; Events 1890 to 1906; Influence of Ballooning as a Sport, Army Aeronautics is Revived; Langley Mechanical Flight Experiments; Aerostation at Fort Omaha; First Army Dirigible Balloon; The Birth of Aviation; the First Army Airplane; Thomas E. Selfridge; Army Flying in Texas, 1910–1911; College Park and August, 1911–1912; College Park, 1912; Aviation in the Philippine Islands; August and Texas City, 1913; The School at Noeth Island, San Diego.

The history of aeronautics in the United States has received a valuable addition through General Lahm's book on the origins of our military aeronautics. Four books in the field have been outstanding. First Major Haydon wrote *Aeronautics in the Union and Confederate Armies*, which gave a scholarly study of the use of balloons in the Civil War. Then Jeremiah Milbank, Jr., wrote the fundamental survey of *The First Century of Flight in America*, and in May, 1943, Fred Kelly's *The Wright Brothers* brought the story of American airplane development up to the period which General Lahm carries forward. The only period that still needs definite source volume is the long term of experimentation with mechanical flight before the Wright Brothers succeeded in solving the problem.

Col. Charles deForest Chandler had the idea of writing the story of the work done at College Park where Wilbur Wright trained the first Army pilots. He collected background material for several years. When he died he left a request that his old friend General Lahm finish the job. General Lahm decided to expand the scope of the book to a history of the beginnings of the Air Corps.

With unequaled ability to locate records and compile them, and writing as a participant in many of the events he describes, the author has written one of the "must" books for anyone who wishes to understand how our Air Forces started.

As a famous balloonist, as well as one of the first two Army pilots, he gives lighter-than-air a more detailed study than a less-informed writer might have done. While less interesting than the use of the airplane by the Army, it is an important and essential part of aeronautical history. The early Army balloonists were ready with knowledge of the mysteries of the air when the airplane arrived.

To the Army pilot the most instructive part of the book will begin with the story of the Wrights and the early attempts of those men who were then called military aviators to develop the flying machine as a military weapon. As General Lahm was one of the most active and persistent proponents of the airplane, he followed its development throughout his career, from the time when he became the first Army officer to fly with Orville Wright in 1908 to his recent retirement as an Air Force officer.

The history will be an inspiration to the thousands of pilots who will wish to know how aviation came up the hard way. The personal quality of the chapters will add to their authority. As the literary executor of another great pioneer in military aeronautics, General Lahm has made another great contribution to the advancement of an understanding of American aeronautics. The Ronald Press Company, New York, 1943; 333 pages, $3.75.

Sea-Flyers

C. G. Grey

Parts: As It Was in the Beginning; Sea-Flying During 1914–18; Airships; Between Wars; The U.S.A. Between Wars; Sea-Flying in This War.

In this book Mr. Grey reminisces as he did in earlier books on fighters and bombers. He describes the earliest attempts to get off the water with aircraft and then follows through with a highly personalized account of each new advance until the seaplane and flying boat became useful as naval weapons. The origin and difficulties of the Royal Naval Air Service, as well as its activities during the first World War and its merging into the Royal Air Force in 1918, are described with biographic sketches of the leading participants.

Airships and transatlantic flights have their chapters. Catapults and their primitive beginnings, and development are also given their place in assisted take-off systems.

The closing chapters of the book give sketches of the better-known designers of flying boats and the companies that build them.

Like all books written by Mr. Grey, this one gives his strong opinions on many controversies. His memory fails him at times when reviewing American affairs, but even when he is sometimes inaccurate he is always interestingly irritating. Faber and Faber Limited, London, England, 1942; 256 pages, 7*s.* 6*d.*

Thirty Seconds Over Tokyo

Capt. Ted W. Lawson

One of the members of Major General Doolittle's band of eighty officers and men who took part in the Tokyo exploit relates the experiences of the group from the time of its formation until its members went their several ways to other areas or to hospitalization.

The story of Captain Lawson's early life is like that of many other pilots. He was a Lockheed employee first and then an Army pilot who had just enough specialized experience to be chosen as one of a select group to engage in an especially hazardous mission. To many, the account of the training period in Florida and the events leading up to the take-off from the "Hornet" will be new, as the official account did not emphasize this part of the exploit.

As is well known, the flight was to take off 400 miles from the Japanese coast in the afternoon and the bombing was to be done at night so that landing of the sixteen North American B-25's could be made in daylight. This plan was suddenly changed when the task force of cruisers and destroyers made contact with an enemy ship. Evidently the protecting screen was not far enough ahead of the carrier to prevent the carrier being seen from a Japanese patrol vessel, which was met and sunk 800 miles from Japan. As the official report said, "it met complications," and Admiral Halsey feared that the Japanese might have been able to use their radio to warn Tokyo.

Therefore, instead of waiting until the evening of Sunday and getting 400 miles nearer to Japan, the flight was ordered at once. The account of Captain Lawson differs from the official account, which states that the take-off was 10 hours ahead of the departure time, whereas he writes: "We'd have to take off now. Not Sunday evening. Now, Saturday morning." This change of plan made it necessary for the 16 planes to fly 400 miles farther than originally planned and probably was

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A shooting war is also a talking war. The weapons of communications must have the same dependability and non-failing action as weapons of destruction. These qualities are built into Utah Parts at the factory where soldiers of production are working 100% for Victory. In Utah laboratories, engineers and technicians are working far into the night developing new answers to communication problems—making improvements on devices now in action.

But "tomorrow" all this activity, all this research, all this experience learned in the hard school of war, will be devoted to the pursuits of peace. Thanks to the things now going on at Utah—there will be greater convenience and enjoyment in American homes . . . greater efficiency in the nation's factories. UTAH RADIO PRODUCTS COMPANY, 858 Orleans Street, Chicago, Ill. Canadian Office: 560 King Street West, Toronto. In Argentine: UCOA Radio Products Co., SRL., Buenos Aires. Cable Address: UTARADIO, Chicago.

PARTS FOR RADIO, ELECTRICAL AND ELECTRONIC DEVICES, INCLUDING SPEAKERS, TRANSFORMERS, VIBRATORS, VITREOUS ENAMELED RESISTORS, WIREWOUND CONTROLS, PLUGS, JACKS, SWITCHES, ELECTRIC MOTORS

Utah

responsible for the forced landings or bailouts of the pilots during Saturday night instead of in the daylight hours of Monday. While the bombing part of the plan was carried out as scheduled, the ending of the flight, which was evidently anticipated by the special orders issued, was one of the tragedies of this historic bombing.

Captain Lawson describes the landing of his bomber in the dark in the surf and the heroic care given to him and his crew by the Chinese and missionaries. He also gives the story of the landing in China and Russia by the other pilots; how five are interned in Russia, two are missing in action, and five are known to be Japanese prisoners of war. Two are presumed to be prisoners of war or killed in action, and sixty-five are known to have escaped.

Captain Lawson was so badly injured that his leg had to be amputated. The flight home and his hospitalization conclude his story, which will be read with mingled pride and regrets. If the "Hornet" could have completed its part of the program and if the pilots had had gasoline supplies for 400 more miles, the ending of the attack would have been different. But to know that our Air Forces have pilots who will take off for an almost certain disastrous ending of a flight will make every man who took part in this epic of heroic adventure worthy of the highest honors that a people can give. Random House, New York, 1943; 221 pages, $2.00.

Sky Master: The Story of Donald Douglas

Frank Cunningham

The life story of Donald Douglas differs from almost all other pioneers in aircraft construction in that he came up through aeronautical engineering. After a normal boyhood in a Scots family in Brooklyn and two years at Annapolis, he was graduated from Massachusetts Institute of Technology. With this training, supplemented by practical experience as an aeronautical engineer with the Army and with Glenn L. Martin, he started his own company, which has had such a brilliant record of achievement.

The biography is not always centered on its principal figure. Interesting sketches are given of those with whom Don Douglas has been associated. Interesting, though diverting, are the airline histories to which the famous D.C. line of transports contributed so much.

All the types built by Douglas, from the Cloudster built in 1921 to the great B-19, are described, so that the book is a history of the Douglas Aircraft Company as well as that of its founder.

To the innumerable friends of the reticent master of aircraft design, as well as of the yacht "Endymion," the book will give a key that will unlock some of the treasure boxes of memories and provide a background for understanding one of the great aeronautical engineers of the world.

The numerous illustrations include pictures of past and present aircraft, including current types of warplanes, family portraits, photographs of famous men in the aeronautical industry, and views in aircraft plants. Dorrance and Company, Philadelphia, 1943; 321 pages, $3.00.

The Luftwaffe: Its Rise and Fall

Hauptmann Hermann

This book will shock those who have believed that the German preparations for a blitzkreig were made in secret. It indicts the leaders of England and France for their failure to heed reports from experts regarding the development of a huge air force in violation of the Versailles Treaty. No book on European air power that has been written since World War II started has given such convincing arguments for the possibilities of the airplane as a war weapon.

As a background, the anonymous author, who was an employee of Dr. Junkers, gives colorful sketches of the men whose determination kept aviation alive in Germany until Hitler discarded all pretense of secrecy. His opinions of the political and industrial leaders as well as aircraft engineers is too definitely personal to be unbiased.

Using the Deutsche Lufthansa as a fulcrum, the German government was able to pry off the lid that sealed airplanes within the casket of treaty restrictions. Aircraft manufacture, research, and air transport operation, as well as pilot training and the construction of municipal airports, were given encouragement. With this as a start, the vast program for the Luftwaffe as conceived by Hermann Goering and backed by Hitler and the Nazi party was an early step.

Correct emphasis is given to the open pride the Germans took in showing foreign visitors their preparations for defense against the growing air arm of Russia. The reports of English, French, and American observers were treated as just air enthusiasts' propaganda for their pet vocation. The English are blamed especially for their lack of foresight.

All of which leads the author into the theories of the strategic and tactical uses of the Luftwaffe. It is shown how the Nazi party hoped to win the war by air power alone and discredit the old Army and Navy leaders. How this was accomplished in Poland, Norway, Holland, and France is well known, but it is not so generally understood that Dunkirk and the Battle of Britain might have had a different outcome if greater stress had been put on long-range bombers.

The characteristics of Goering and Milch, as well as the other principal officers of the Luftwaffe, are analyzed and their roles in the sensational rise of air power will show what a desperate group is being met by the R.A.F. and the A.A.F. in their softening attacks on Germany.

The failure of the Luftwaffe to accomplish its full purpose and the gradual lessening of its power is believed by the author to be a prelude to the end of the war. To the ascendency of the German Army officers in influence on Hitler is attributed much of the lessening of the supremacy of the Luftwaffe.

Although this book is about the uses Germany has made of air power, it gives a much broader view of aviation, since it uses the Luftwaffe's successes and failures to indicate the trend of air strategy and tactics. G. P. Putnam's Sons, New York, 1943; 300 pages, $3.00.

"Wildcats" Over Casablanca

Lt. M. T. Wordell and Lt. E. N. Seiler
as told to Keith Ayling

The operations of the American forces in the attack on North Africa had so many elements of air, sea, and land power that it has been difficult to separate and evaluate them. Two Grumman Wildcat pilots who flew from a carrier have now given a vivid picture of the part taken by naval aviation in the landing attack. From cover to cover it is a human-interest story as pilot after pilot tells of his experiences. The result is that the reader receives a clear picture of the preparations for action on a carrier, the objectives to be achieved, and the way many pilots engaged in air combats and gunned ground targets.

Not only is the view from the air given, but the experience of "Mac" Wordell, who had a forced landing and was made a prisoner, shows what life on Casablanca was like during the raid and after the occupation by the U.S. Army.

The book will interest not only those who follow the emergence of air power in the war but will add another source for historians after the war. Little, Brown and Company, Boston, Mass., 1943; 309 pages, $2.50.

Flying Fortress: The Story of the Boeing Bomber

Thomas Collison

Few airplanes since the classic Jenny series of Curtiss planes have had the spectacular career in the air that the world famous Fortress types and their antecedants have had. Mr. Collison not only traces the origin of this bomber type but gives an excellent record of the earlier aircraft produced by the Boeing Aircraft Company. One could almost get the entire story from the exceptionally carefully selected illustrations that are not only profuse but are reproduced in brilliant gravure.

The romantic story of the Boeing parallel development of transport and military types is told with emphasis on the careful engineering background of each step in the upward climb to the present astonishing production of Fortresses at Seattle. While future progress is veiled in secrecy, any reader with imagination can let his mind project even more advanced aircraft planned for the coming months and years.

Pictured above is an exploring loop attached to a high-frequency noise meter, used by the TITEFLEX *experimental laboratory to test the shielding qualities of* TITEFLEX *harnesses.*

ANY small electrical leakage in the ignition shielding harnesses of Allied planes might easily forewarn the enemy of our planes' approach. One small electrical leak, and the plane's communication system would be impaired — preventing contact with home bases or squadron leaders — and interfering with signals which guide them safely home.

Conscious of their responsibility of manufacturing perfect shielding for use on Allied aircraft engines, TITEFLEX Metal Hose Co., is constantly devoting its engineering research facilities to the development of improvements in radio shielded ignition harnesses.

In the past few months TITEFLEX has engineered improvements in the end connections, spark-plug elbows, flexible conduit and clips for bonding conduit to the engine proper. Through such engineering development—TITEFLEX is contributing to greater safety for the men who fly U. S. planes in war and peace. Titeflex Metal Hose Co., 514 Frelinghuysen Avenue, Newark, N. J.

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RADIO, POWER, AND IGNITION SHIELDING — CONDUIT, FITTINGS, COMPLETE ASSEMBLIES — HIGH PRESSURE FUEL, OIL AND AIR LINES

Books such as this will be of great assistance in giving the public a better understanding of the fundamental requirements of successful aircraft design, the extensive engineering that is necessary to produce progressively advanced types, the problems that are solved by the test engineer, and, finally, the intricacies of aircraft manufacturing. Charles Scribner's Sons, New York, 1943; 168 pages, $2.50.

Air Power and Total War

Cy Caldwell

Chapters: The Nature of War; The Birth of Total War; Air Power, the New Factor in War; The Growth of Air Power; Blitz Warfare; The Battle of Britain; The Doctrine of General Douhet; The Air War of Attrition; The Air War in Russia; Norway, Crete, and Malta; Pearl Harbor, the Philippines, Singapore; Aircraft Carriers; Limitations of Armies and Air Forces; The Bombing of Germany; The Great War of Lost Chances; Experts and Total War; A Glance at the Future.

To understand Cy Caldwell's latest and most ambitious survey of air power it is recommended that the reader get the author's conclusions in the last two chapters before reading the other parts of the book. He dissects the claims of the other "air experts"—Douhet, Mitchell, de Seversky, Ziff, and Williams—and gives a definition of an air expert as "an airman who gradually learns more and more about less and less aviation, or learns less and less about more of it."

With this crushing criticism in mind, the admissions of previous errors of opinion on the part of the author are understandable. The reader will agree with Pope's dictum: "Who shall decide when doctors disagree, and soundest casuists doubt, like you and me?"

In a general review of the present air war this prolific writer gives his opinion as to the constant mistakes of the politicians, the military and naval leaders, and the strategists. However, he does not take the pontifical attitude of advising the generals, the admirals, and the air marshals how to run the war. The book is a brave effort to give the impression of detached impartiality on probably the most controversial subject now being discussed not only in the United States but in all other countries. He admits that airmen may have been a war ahead in their reckoning but rightly foresees that the progress of civil aviation in times of peace will parallel or possibly precede the advances in military or naval development. Coward-McCann, Inc., New York, 1943; 244 pages, $2.50.

War Wings

David C. Cooke

Chapters: Pursuits and Fighters; Light and Medium Bombers; Heavy Bombers; Flying Boats and Seaplanes; Training Planes; Miscellaneous Types; American Planes in the R.A.F.; How to Tell U.S. Warplanes.

Identification of airplane types has passed from the pastime of youth to the serious avocation of the aircraft observer. Formerly, boys prided themselves on the number of kinds of airplanes that they could identify and possibly reproduce in model form. Now thousands of volunteers are gazing skyward night and day to keep the Army informed of air traffic. To do this accurately requires skill in recognition of civil and military aircraft.

War Wings does not give silhouettes, but through text and excellent pictures it differentiates not only the types themselves but places them in groups.

By limiting the scope of the book to the fighting planes of the American and British air forces, the author has been able to give more complete descriptions than if he had attempted to describe enemy aircraft as well.

The text is not critical but informative and the illustrations are carefully selected. Robert M. McBride & Company, New York, 1943; 228 pages, $2.75.

Attack Can Win in '43

Max Werner

The author, who has made many other generalized predictions in previous books on military strategy, makes the claim that either victory must be won by invasion in 1943 or the United Nations must face a seven-year war—if priority is given to fighting in the Pacific over the fighting in Europe or if a decision is made to wage predominantly an air or sea war. With this as his thesis he gives his reasons why he believes the Red army can win and how the German army can be defeated. His opinion of air power is directly contrary to that of Douhet and other proponents of the full-out use of the strategic bomber. It is challenging to read page after page placing air power back as an adjunct to the armies.

A more optimistic book on the possibilities of defeat of Germany by invasion on the West and crushing of the German armies on the East has not been written. The results so far this year do not justify the author's bold assertions. However, one can but hope that the jacket of his next book can claim that his foresight is as accurate as the publishers claim it has been ever since 1938. Little, Brown and Company, Boston, 1943; 215 pages, $1.75.

War Planes of All Nations

William Winter

Any author who attempts to give descriptions of all the airplanes used by the Allied nations as well as their enemies undertakes an almost impossible task. Mr. Winter has made a brave effort to assemble this information, no matter how fragmentary or possibly out of date because of rapid changes. The result has been to provide a compact and inexpensive book which by text, photographs, and three-view plans provide all the information currently available to the public on the aircraft now in use in the war.

Of exceptional interest, and showing great research, are the sections on Russian and Japanese types. Despite all the secrecy that surrounds the developments of these countries, the author has been able to give descriptions and dimensions of many of the aircraft which have proved to be so devastating to the Germans and so surprising to our own air forces in the Pacific area.

At this time, when so many thousands of our pilots need to be acquainted with the characteristics of the aircraft of friend and foe, this handbook giving the descriptions of nearly 300 military aircraft will be extremely useful and helpful. Thomas Y. Crowell Company, New York, 1943; 418 pages, $3.00.

The Fight for New Guinea

Pat Robinson

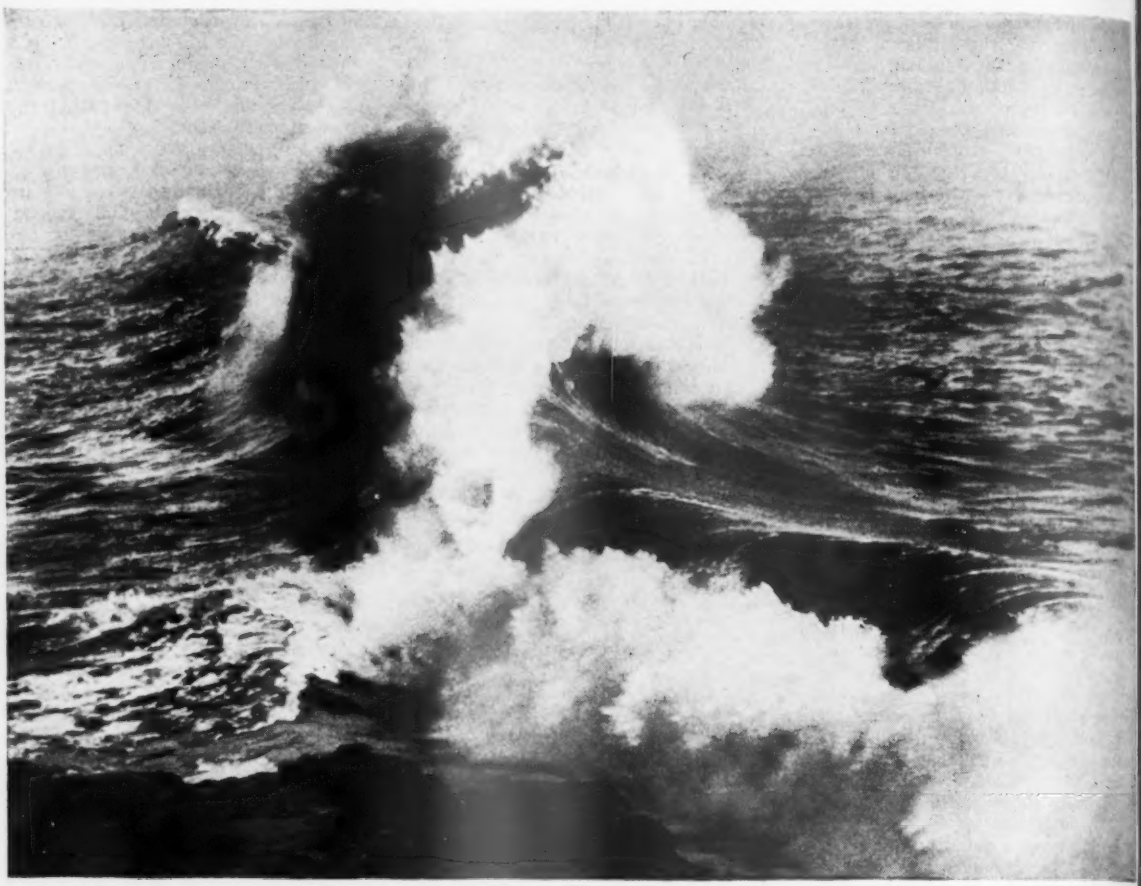
The news of the progress of the war concerns so many fronts that it becomes disconnected. It is only when a book is about one front and one campaign that the picture is clear. Much has been written about the success of air power at Crete, Tunisia, Midway, and Pantelleria, but the author of this book makes clear that air power alone saved Australia and took part of New Guinea away from the Japanese. General MacArthur gives full credit to Lieutenant General Kenny for his able handling of the American Air Forces. He is quoted as saying that he considered Kenny the greatest air commander in the world today, "an opinion shared by everybody in the Air Corps in the Southwest Pacific."

Nearly every page of the book tells the story of an exploit of a pilot. As they come from an eyewitness or a reporter who heard the accounts at first hand, the record of heroic gallantry of a meager air force makes the account one of the most vivid war books yet written. Anyone reading the story of this critical offensive will get an inside view of the Australian point of view and the determined strategy of General MacArthur. It ranks with the best as documentary evidence of what air power can do when it has to act independently as a combat and transport force. Random House, New York, 1943; 183 pages, $2.00.

God Is My Co-Pilot

Col. Robert L. Scott

Colonel Scott, who commanded the China Air Task Force under General Chennault, has written one of the most interesting biographic books that have come out of experiences during the war. His early career as an Army pilot is typical of many others, but as one of the Air Corps pilots who were suddenly called on to fly the mail after the



This is the reason they called the tube KLYSTRON*

Does it seem far-fetched to you?

Can there be any possible similarity between an ocean wave and an ultra-high frequency tube?

As a matter of fact, there's a very definite similarity.

A breaking wave is the best way we know to picture what happens to electrons in the KLYSTRON tube invented by the Varian brothers—Russell and Sigurd—and Dr. William W. Hansen.

Inside this tube, the inventors were able to direct a stream of electrons which concentrated their power and released it much as waves do when they mount into crests and crash on the shore.

That's why the tube is called KLYSTRON. The name comes from a Greek word that denotes the breaking of waves on a beach.

Initial research on the KLYSTRON was done in California at Stanford University. The Sperry Gyroscope Company was quick to see the tube's possibilities. So they helped the inventors carry on further development of the KLYSTRON as a valuable tool of war and aeronautics.

When the tube got beyond the early experimental stages, the Varian brothers and Dr. Hansen joined Sperry's staff of inventors, engineers, and research men.

With the close co-operation of the Army and Navy, the development and perfection of the KLYSTRON continued, and is still continuing.

Applications of the KLYSTRON include the generation, amplification, and reception of ultra-high frequency waves. Naturally, they are being devoted exclusively to war uses at present.

When the war is won, Sperry research will explore the fascinating field of KLYSTRONICS** in relation to the comfort and security of a world at peace.

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GYROSCOPE COMPANY, Inc.
BROOKLYN, N. Y.
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**Trademark

cancellation of air-mail contracts by the Post Office in 1934, he gives a participant's view of one of the saddest episodes of American aviation. Flying obsolete airplanes with little or no navigational aids, the Army pilots flew over routes new to them, through exceptionally bad weather conditions, until the death of so many caused the Government to turn the service back to the air lines.

The book was dictated and therefore is conversational in its style of presentation. The author is a born story teller, and as he relates his flying experiences in Africa, India, Burma, and China the reader gets a clear impression of what our pilots are encountering in our extended air routes.

Of course, the most impressive part of the book is the account of the work of the Flying Tigers and, more recently, the work of our Air Forces in China. Chennault's tactical methods of attack and defense with aircraft, the performance of which is exceeded by the enemy, are fully described. It is one of the outstanding achievements of our airmen and has demonstrated to the world how American pilots guided by an experienced leader can overcome seemingly insuperable obstacles.

God Is My Co-Pilot will always be one of the books that could only have been written by a fearless and able fighter who was determined to come to grips with the enemy in the air. It gives a first-hand account of war in the air as it is developing. Charles Scribner's Sons, New York, 1943; 277 pages, $2.50.

Aircraft Construction Handbook

Thomas A. Dickinson

Chapters: How an Airplane Factory Operates; Aerodynamics; Aircraft Types and Nomenclature; Aircraft Design Principles; Materials and Processes; Shop Practice; Assembly; Inspection.

A complete and practical explanation of the process of constructing aircraft is presented in language that can be understood by those who have had no special training in the subject. The author describes how an aircraft plant is laid out, how it operates, and what qualifications a man should have for various kinds of work. In the section on aerodynamics, a simple explanation is given of what makes a plane fly. The author explains the classification of airplanes and describes how a plane is created for the purpose it is meant to perform. Metals and other substances used in aircraft and the methods of treating them are discussed. Other subjects cover jigs and fixtures, riveting, and types of inspection. An appendix is provided containing tables, charts, and mathematical short cuts. There is a glossary containing words and terms that are part of the aircraft worker's language. Thomas Y. Crowell Company, New York, 1943; 237 pages, $2.50.

Electronic Control of Resistance Welding

George M. Chute

Parts: Ignitron Contactors, Tubes and Weld Timers; Synchronous Control of A-C Welding; Energy-Storage Welding.

Offered as a practical manual containing information on the tubes and circuits used to control resistance welders in industrial plants, this book is designed to aid those who work with and maintain these controls. The author first gives the reader a simple electrical background and then furnishes detailed explanations and diagrams of tube circuits, including synchronous timers and stored-energy controls. How tubes work in their circuits is described in a treatment that starts with the picture of a complete welder control in service and adds detailed fundamental background as the need arises in the study of specific devices. McGraw-Hill Book Company, Inc., New York, 1943; 389 pages, $4.00.

Airplane Structural Design

Elmer F. Bruhn

Chapters: General Theory of Stress and Strain Calculation; Column Theory; Summary of Information on the Buckling and Ultimate Strength of Thin Sheet Units; Practical Applications to Airplane Structural Analysis and Design; The Loads on the Airplane.

A book containing material developed and used by the author for a beginning course in airplane structures. The notes present over 175 example problem solutions with over 1,000 figures and sketches to help explain the basic theory. The first few chapters of Part A comprise a review of statics with special attention to aeronautical angles of the subject. The remainder of this section deals with more advanced applications of the fundamentals of statics and continuity, with many applications to typical airplane problems. Part B of the notes summarizes the general information and theories for determining and estimating the buckling and ultimate strength of thin sheet units. Part C deals with the application of the theory and information in Parts A and B to the design of typical airplane units. Part D, which deals with loads on the airplane, is not complete. The notes in their present state consider only loads on the wing and body. The author intends to furnish additional notes on the subject as time permits. Planographed and distributed by John S. Swift Co., Inc., Cincinnati, O.; $4.50.

Air Transport Navigation

Peter H. Redpath and James M. Coburn

Chapters: Airways; Aeronautical Charts; Compasses; Air Navigation Instruments; Course Plotting, Course Conversion and Simple Bearings; Determination of Groundspeed and Fuel Consumption; Wind and Its Influence on the Navigation of Aircraft; Aircraft Radius of Action and Simple Interception; Navigational Dead-Reckoning Computations; Flight Planning, Flight Logs, Scheduling; Radio Aids to Air Transport Operation; Radio-Range Flying; Instrument Approach Procedures; Radio-Range Orientation; Airplane Direction-Finding Equipment; Simple Homing and D/F Calibration; Direction Finding (D/F); Link Trainer; Instrument Landing; Ultra-High-Frequency Radio Ranges; Routing Navigation Practice; Airline Flight Dispatching; Heavens Above.

A book furnishing a background for those who are contemplating a career in aviation transport. It contains information for the transport pilot, the navigator, and also for the private pilot. Dead reckoning and radio direction finding have been joined, and most of the information on the combined subjects is offered as original. Meteorology purposely has been omitted because of space limitations. The text is so arranged that the information desired is easy to derive. Pitman Publishing Corporation, New York, 1943; 612 pages, $5.00.

Cross Country Flying

Carlton L. Wheeler

Chapters: Flight Syllabus; Definitions; Maps and Charts; Advanced Aerial Navigation; Interception—Patrol—Search; Navigation Problems and Use of Computer; Problems for Practice; Flight and Navigation Instruments; Plotting—Flight Plans—Logs; Cross Country Flying; Radio Aids and Navigation; Traffic Control; Applied Meteorology; Civil Air Regulations; Cross Country Examination Questions.

Prepared especially for the Civil Air Patrol pilot, the private pilot or the pilot who wants an instrument rating, and the commercial pilot. Principles of cross-country flying are set forth and other essential information on the subject is given. An outline is given of the 42 flight lessons required for the controlled cross-country course of the Civil Pilot Training program. Following the text, there is a final examination consisting of 200 questions. Carlton L. Wheeler, Penn Yan, N.Y.; 90 pages, $2.00.

Smoke Streams: Visualized Air Flow

C. Townsend Ludington

Chapters: Visualized Aerodynamics; The Griswold Smoke Tunnel; Lift; Airfoil Sections and Lift; Drag; Improvements in the Airplane; High-Lift Devices; Downwash Effects—Tail Location; Wing-Tip Losses; What the Airplane Wants to Do (by Wolfgang Langewiesche); What the Pilot Wants the Airplane to Do; Miscellaneous Air-Flow Phenomena; Building a Miniature Two-Dimensional Smoke Tunnel.

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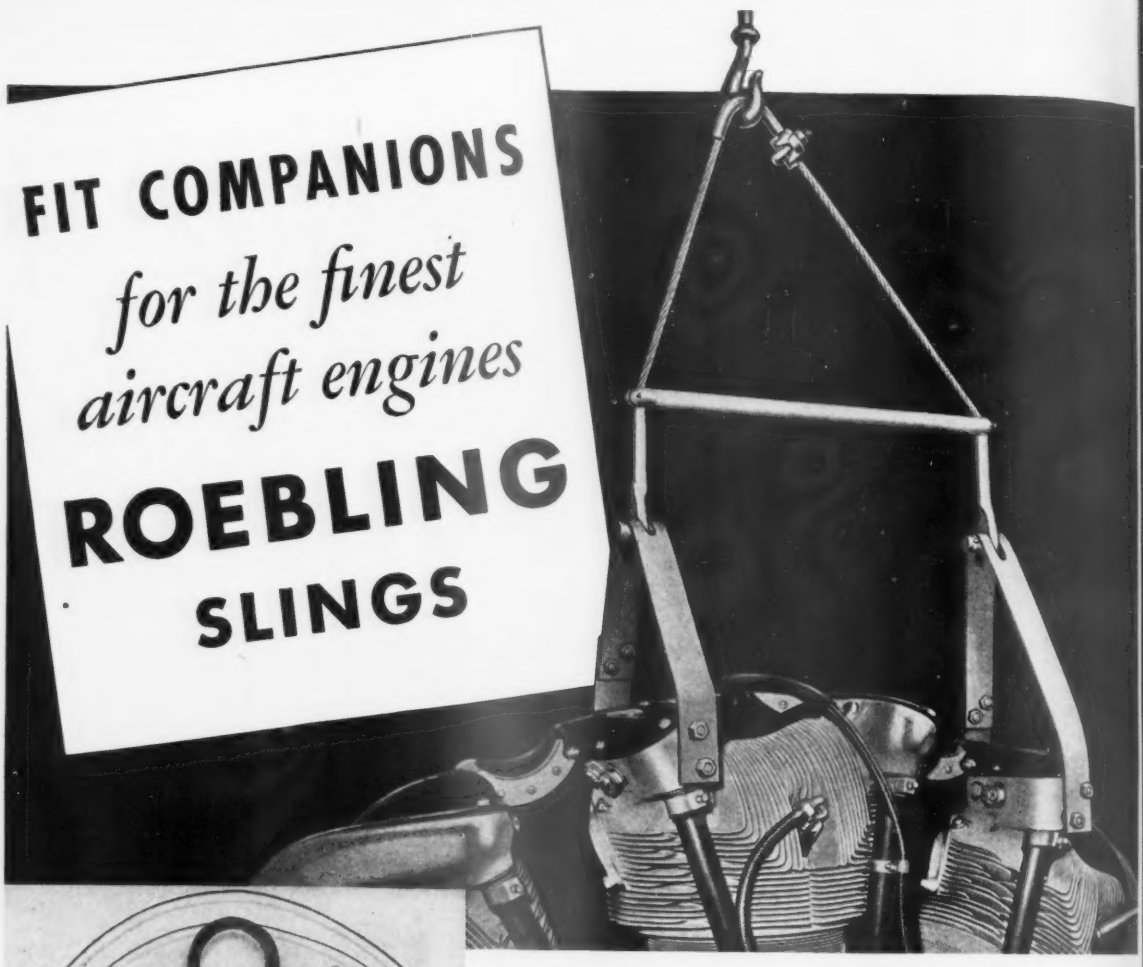

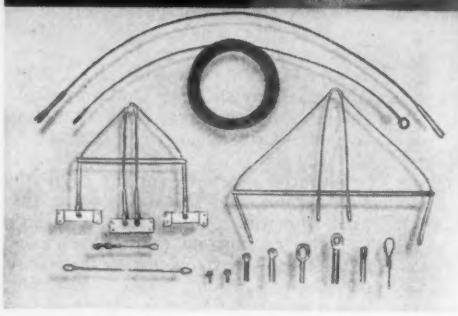

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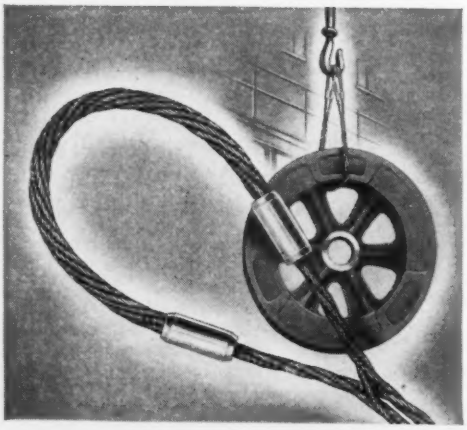

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The author and his associate, Roger Griswold, have used a new technique in explaining to the student of aerodynamics and the lay reader the principles of the action of the air around the surfaces of solids. By the use of photography and of smoke streams in a specially constructed wind tunnel they have evolved an excellent textbook of visualized aerodynamics.

Starting with the simple effects of airflow over airfoils, the book proceeds to give an explanation of the phenomena of high lift devices, down-wash effects, and wing-tip losses. Wolfgang Langewiesche writes a chapter on "What the Airplane Wants to Do," which is followed by one taking the opposed position of what the pilot wants the airplane to do.

The book will be useful in giving students a clear idea of visualized airflow and will be particularly helpful in demonstrating to young men who intend to become pilots the behavior of the medium through which they hope to fly. Coward-McCann, Inc., New York, 1943; 144 pages, $2.75.

Air Power

The Editors of *Look* Magazine

A dramatic picture story of the many vital activities carried on by the Army Air Forces in the course of waging the war. In a section on the training of flying and technical personnel, important aspects of the work of the training commands are shown graphically. There is a picture story of a bomber crew and photographs of important bombers of the Army Air Forces. Releasable data on these planes are furnished. The fighter plane is treated in a similar manner. There is a full-color picture story of a unit of the Army Air Forces in action. Drawings show the historical development of Army aircraft. Leaders of the Army Air Forces are portrayed in pictures with brief biographies, and the insignia used are shown. As a guide for aircraft spotters, silhouettes of Army aircraft are furnished. Duell, Sloan & Pearce, Inc., New York, 1943; 97 pages, $2.75.

Aerial Photographs and Their Applications

H. T. U. Smith

Chapters: Characteristics of Aerial Photos; Stereoscopic Study of Aerial Photos; General Principles of Photo Interpretation; Geographic and Topographic Interpretation; Planimetric Maps from Vertical Photos; Planimetric Maps from Oblique Photos; Photo-Mosaics; Contour Maps from Aerial Photos; Geologic Interpretation; Physiographic Interpretation; Aerial Photos in Economic Geology, Engineering, and Other Fields.

The elements of aerial photographic mapping and photo interpretation are presented. Emphasis has been placed on practical working procedure, but underlying principles are treated at sufficient length to make for an intelligent approach to practice. Written with a view to wartime requirement, the book provides the necessary background both for direct applications of photos in military operations and for indirect applications in the mapping of strategic areas and in the search for and development of mineral deposits. The major part of the book is devoted to aerial photo interpretation. The volume is written for students having an average general background in science or engineering. D. Appleton-Century Company, New York, 1943; 372 pages, $3.75.

Aircraft Power Plants

Arthur P. Fraas

Chapters: Engine Operation; Engine Installation; Propellers.

This book on airplane power plants has been written to fulfill the requirements of engineering college seniors and of graduate engineers in the armed services or aircraft industry. While the author has made every effort to make the treatment as simple as the subject permits, a familiarity with college physics, thermodynamics, and fluid mechanics is required. Both the method of presentation and the material included are based on experience gained by the author in teaching courses in this subject to classes of U.S. Army and Navy officers, senior and graduate students in aeronautical engineering, and engineers actively engaged in industry. The reader is provided with the fundamental terms and concepts that will give him a good background of information on all phases of the subject. Books useful to the student for supplementary reading are listed at the end of each chapter. McGraw-Hill Book Company, Inc., New York, 1943; 472 pages, $4.50.

Arctic Emergencies and Jungle and Desert Emergencies

These two handbooks give to crews of aircraft who make emergency landings in the jungle, desert, or the Arctic the essential information needed for them to await rescue or make their way to settlements.

The advice in all cases is to stay with the airplane rather than to bail out. The especially useful equipment that should be saved, methods of signaling and the care of a damaged bomber or fighter, and how to live off the land are described in detail. Sanitary precautions and the care that must be used in preparation of water and food will prevent much unnecessary hardship. Edible and poisonous foods are carefully distinguished.

Both books, although not available for general circulation, make invaluable guides to life in solitary places of the world and how to live there in emergencies. U.S. Army Air Forces, Flight Control Command, Safety Education Section.

Book Notes

Chennault of the Flying Tigers, by Sam Mims; Macrae-Smith Company, Philadelphia, 1943; 255 pages, $2.00.

The most legendary figure in prewar flying is undoubtedly Claire Chennault, former Army pilot whose Chinese American Volunteer Group made such a notable record. This book gives the story of his family background and his boyhood before he decided to become a pilot. Always daring in his theories of flight as well as his flying, he did not see eye to eye with his superior officers and left the service on the grounds of physical disability. As one of the "Three men on the Flying Trapeze" he had thrilled thousands at the National Air Races and other meets.

The author, who had access to family correspondence, gives a personalized picture of Chennault's decision to go to China, the difficulties he found, the organization of the A.V.G. or "Flying Tigers" and their eventual entry into the U.S. Army Air Forces as the Twelfth Air Force.

Major General Chennault has solved the mysteries of Japanese flight technique and is using his knowledge to the advantage of the Allied forces in China.

Wrath of the Eagles, by Frederick Heydenau; E. P. Dutton & Company, Inc., New York, 1943; 318 pages, $2.50.

This novel is about the followers of General Mihailowitch of Yugoslavia who, without planes, without artillery, and without tanks, have conducted such an interesting guerilla warfare against the German invaders.

The story opens with the arrival of three American submarines at a point on the Yugoslavian coast, carrying supplies to the Chetniks. A young American ensign decides to stay with the guerilla warriors until his ship is ready to leave and, through his experiences, the reader learns about their activities, their attacks on the foe, their privations, and their victories.

Life Out There, by Sgt. Johnny Bartek; Charles Scribner's Sons, New York, 1943; 117 pages, $1.75.

Dean Pardue helped Johnny Bartek write of his experiences during the 21 days when he, Eddie Rickenbacker, and others of the Flying Fortress crew were having their dangerous wait for rescue on the Pacific. The story has been told so graphically by Captain Rickenbacker himself, as well as by news commentators, that another version of it had to be different. This has been achieved in

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this book by using the language of an airplane mechanic, such as is heard about every hangar at a flying field. Bartek tells how it feels to be a hero and gives his impressions of the reactions of the public.

The emphasis on the religious transformation of some of the men on the rubber raft is carried through the whole book, which concludes with eleven pages incorporating what Johnny read from the New Testament while on "the trip."

The book is inspirational in intent and will certainly be unique among the biographic books that are appearing almost daily.

Analytic Mechanics, by Sherman Daniel Chambers in collaboration with Virgil Moring Faires; The Macmillan Company, New York, 1943; 375 pages, $3.75.

A textbook for the study of analytic mechanics, this is a revision of an earlier book by Mr. Chambers called *Mechanics of Engineering*. Although it is a completely rewritten version, it follows the basic organization plan of the original. Few new topics have been added, but the explanations and discussions have been made more complete and a greater number of problems has been included.

The text is so written that the student is led gradually from the elementary conceptions of analytic mechanics to the more difficult ones. While no effort has been made to avoid the use of the calculus, the mathematics encountered is usually simple. For the most part, the answers to the problems are slide-rule answers.

Transport for War, by Edward Hungerford; E. P. Dutton & Co., Inc., New York, 1943; 272 pages, $3.00.

There is one chapter in this book which concerns air transport. As the author states frankly that he has never flown on an airliner, it is to be expected that his description of air transport is derived from reading and hearsay. The results are not too satisfactory and, while the book may be interesting and accurate as a description of the war uses of ship, railroad, and highway transport, it is not so accurate when the author leaves the ground.

The Aircraft Year Book for 1943; edited by Howard Mingos; Aeronautical Chamber of Commerce of America, Inc., Washington, D.C., 1943; 728 pages, $5.00 (distributed by Lanciar Publishers, Inc., New York).

The twenty-fifth edition of this standard annual of the Aeronautical Chamber of Commerce, edited by Howard Mingos, is again the indispensable reference book of the 1942 record of aviation.

As usual, the book gives a review of the accomplishments of the military and naval air arms. This year it is a great record of actions in battle. The Civil Air Patrol, training for war aviation, and other government wartime activities are described in detail. Organizations that have aeronautical interests report their progress for the year. The great contribution of the air lines to the war effort in providing material and personnel for military and naval transport is given full credit.

The greater part of the annual naturally is given to the activities and products of the aircraft industry. These pages are illustrated by photographs and excellent three-view drawings of as many airplanes as is permissible.

The statistic and directory sections provide the references that are always so useful. The 205 illustrations give pictorial impressions of how the aircraft industry has expanded during wartime.

Basic Problems in Engineering Drawing, by William Wirt Turner; The Ronald Press Company, New York, 1943; 53 pages, $1.25.

A course of instruction in engineering drawing is furnished in the form of a series of work sheets. Forty-two work sheets cover in logical progression the basic phases of engineering commonly given in a first-year course. The sheets are intended to be used with the customary lectures and tests. In formulating the series the author has aimed at giving the student the maximum of basic work in a minimum time. Time is saved by adhering to fundamentals and avoiding the inclusion of material not required in a first course.

Blue-Print Reading (revised edition), by D. E. Hobart; Harper & Brothers, New York, 1943; 57 pages, $1.00.

First published under the title of *Notes and Problems in Blue-Print Reading*, this is a revised text on the interpretation of orthographic projections. It teaches the fundamentals of how to read blueprints of machine drawings. To help the reader to full comprehension of blueprint reading, a section is included which explains the method of drawing an object's picture from its views.

A Manual of Mechanical Movements, edited by Will M. Clark; Garden City Publishing Company, Garden City, N.Y., 1943; 254 pages, $1.98.

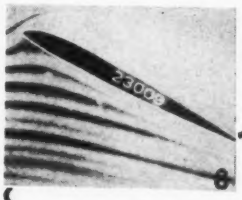
A study of the rudimentary principles on which all machines are built and of the application of these principles in methods of transmitting and controlling movement. The book is divided into two parts. Part One, explains the fundamentals in mechanical movement; the control of simple mechanical movement; timing and regulation of movement; releases, clamps, brakes and stops; special types of movements; and applied mechanical movement. Part Two consists solely of a collection of photographs. These photographs represent working models which set forth in tangible form the application of the principles described in Part One. A glossary of terms is included in the subject matter.

Readings in Military German, selected and edited by W. W. Pusey and A. G. Steer; D. C. Heath and Company, Boston, 1943; 316 pages, $1.50.

A collection of readings in German specifically selected to familiarize the reader with the German military vocabulary. The material consists of articles from German periodicals on the German army, navy, and air force. A concise treatment of elementary German grammar is included in the book, with a large number of examples taken from the text itself. There is also a vocabulary supplement that lists compound words by their final as well as by their initial elements.

Aircraft Descriptive Geometry, by Walter Vaughn; Aircraft Publishing Company, Glendale, Calif., 1943; 200 pages, $3.50.

A revised edition of a book on a method of developing and locating airplane structures in a three-dimensional space. The subject was originally published in two volumes but has been rewritten and combined into one volume for the convenience of the instructor and student. The illustrations have been redrawn or revised and new illustrations and photographs have been added. The new volume has been designed to reflect the advancement and progressively higher standards of the aircraft industry.



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Smoke Streams

By C. Townsend Ludington

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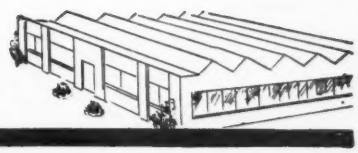

Power-Operated Gun Turrets

A "Must" Delivered. This article on The Glenn L. Martin Company's role in developing and producing power-operated gun turrets includes explanations of the function, advantages, and operation of powered turrets. It tells of the type of hydraulically and electrically operated turrets being supplied to the Army and Navy by the Martin company. Several features in the production of these components are mentioned. One is the casting of the inner ring as a single piece weighing 75 lbs.; another, the one-piece casting of the turret "chasis"; a third, the speed with which the turret parts are assembled. *The Martin Star*, July, 1943.

The "2600"

The Cyclone 14. The genesis and development of the Wright Cyclone 14 engine are reviewed. Claiming the Cyclone 14 as the first of long-range, high-horsepower aircraft engines, the article describes the building of this engine and the characteristics that distinguish it. U.S. Navy airplanes powered by this engine are mentioned. The article is supplemented by a graph that indicates how the 14 moved ahead of the "normal" trend in aircraft-engine power increase. *Trade Winds*, June, 1943.

Altitude Conditions and Aircraft Engines

Farmingdale—Alt. 40,000 Ft. Everard M. Lester. A detailed description of the refrigeration system installed by the Ranger Division of the Fairchild Engine and Airplane Corporation to help determine more fully the effects of altitude on aircraft engines. The installation produces a continuous flow of cold rarified air in large volume, which can be used as the air supply to the carburetors of engines on test in special cells containing equipment for the measurement of engine power output. By changing the temperature and pressure of the air, any altitude condition up to 40,000 ft. can be duplicated and resulting changes in engine power can be noted. Supercharger testing can also be accomplished with this refrigerated air. The method utilizes a dehydration and temperature control system which is explained.

A general discussion of the effects of extreme changes in air conditions upon airplane and airplane-engine performance precedes the data on the Ranger cold room. *The Pegasus*, July, 1943.

Global Geography

To furnish a better understanding of the global geography of a sky-linked world, Consolidated Vultee has issued a book titled *Maps and How to Understand Them.* A historical outline of map making is first presented. Advantages and disadvantages of the Mercator projection are outlined. It is stated that the most important rule to remember when studying the Mercator projection or any map of the world is: when in doubt, turn to the globe. People are beginning to think more and more of the earth as a sphere surrounded by a navigable ocean of air several miles deep. This is changing ideas about geography. The public is turning to the globe and to maps that are projected in such a way that they show true distances. Among the maps shown is a Polar azimuthal equidistant projection and an azimuthal equidistant projection centered on Washington, D.C. Time in the air age is discussed. A global geography quiz is furnished. *Consolidated Vultee Aircraft Corporation.*

Infrared Process

Fostoria infrared process equipment is described in a 16-page catalogue designated as No. 29. It is explained that while the infrared process has been employed regularly by industry for several years, the full extent of its usefulness is still to be learned. Some applications of the process are mentioned. Infrared energy is used to bake paint, preheat plastics, set glue, preheat metals, and for many other purposes. Specifications and illustrations of Fostoria infrared lamps are furnished. *The Fostoria Pressed Steel Corporation*, Fostoria, O.

Welding Materials

The Story of Welding Rods. An article relating how welding rods are manufactured and furnishing notes on the properties and selection of welding rods. The development of welding rod specifications is discussed. It is explained that, in addition to the metallurgic properties and chemical composition, specifications cover processing, marking, sizing, testing, and packing and also provide for the constant inspection and supervision of all phases of manufacture by specially trained metallurgists. Operations in the steel mill and tests while in ingot, billet, and coil form are described. Weld test methods are outlined. As a guide in choosing the right rod for a particular job, brief descriptions of the more common Oxweld rods are *Oxy-Acetyelene Tips*, July, 1943.

Tube Flaring Machine

Suggestion of the Year Averts Bottleneck as Machine Supplants Manual Method. A description of the machine that has replaced the manual method of tube-flaring at the Chance Vought Aircraft Division. Suggested by two employees and judged the prize employees' suggestion of the year, this device consists basically of two rotating cones placed side by side so that their points nearly make contact. The piece of tubing, the open end of which is to be flared, is held by steel jaws in the proper position on a straight line with the rotating points. Then, by means of a lever, the tube is moved and brought into contact with the revolving points, thus forming a perfect flare. *The Bee-Hive*, April–May, 1943.

Handbook on Prints

A handbook of print-making and processing has been issued. It covers the use of blueprints, direct process prints, sepia prints, and reproduction tracings and lists the advantages of each. This 40-page handbook is designed to save time and effort on the part of those charged with the installation and supervision of reproduction departments. The Revolute revolving contact principle of printing is described, as well as the different types of lamps used for exposing the sensitized materials. Information and specifications on Revolute printing equipment are given. The new 8Q printer, designed to meet the requirements of industries whose print production has graduated from the small to the intermediate stage, is described. *Paragon Revolute Corporation*, Rochester, N.Y.

History

El Correo De Mañana (Mail Service of Tomorrow). The growth of the air-mail service in Mexico is recounted. It is recalled that on April 15, 1928, the first air-mail service was inaugurated in Mexico. The medium of transportation was a Fairchild airplane, equipped with a 420-hp. Wasp engine and a reinforced wooden propeller. Three short flights carried the mail from Mexico City to Tuxpan and Tampico.

Today the air-mail service covers 19 important cities of the Republic of Mexico and has been extended to Havana, Cuba, and Los Angeles, Calif. The aircraft used are twin-engined

Clippers of the Compañia Mexicana de Aviación and Pan American Airways. *Caminos Del Aire*, April, 1943.

Structures Engineering Group

Destruction Is Their Business. Bernice K. Platt. An article on the work of the structures engineers of Vega Aircraft Corporation. Various tests conducted by this department are described. These include the positive high angle-of-attack wing test, the destruction wing test, and the drop test. Briefer notes are given regarding fatigue, vibration, and tension tests. *Lockheed-Vega Aircraftsman*, June, 1943.

Wing Design

Inverted Gull Wing Features Corsair Design ... The aerodynamic and structural advantages of adopting a wing design for the Chance Vought Corsair which resembles an inverted gull wing, are explained. One reason given for the decision is that the gull wing makes possible the use of a shorter, lighter landing gear than would be possible on a straight-wing airplane and enables the gear to fold readily aft within the available width of a wing. Another reason is that the use of the gull wing maintained the right-angle intersection of the fuselage-wing attachment and yet possessed the advantage yielded by the extra-large propeller.

Special tools designed for the quantity production of the Corsair also are mentioned in this article. *The Bee-Hive*, April–May, 1943.

Coast Guard Aviation

The Good Samaritan Goes to War. A brief article on the history and development of U.S. Coast Guard Aviation. The duties of the Coast Guard Air Force are recounted, while figures are given on the number of hours and miles Coast Guard planes have traveled on search missions and the number of patrol flights they have made since Pearl Harbor, their personnel, airplanes, etc. *Trade Winds*, June, 1943.

Instructional Manuals

Leather Bound Lifesavers. Ronald Kirkbride. This article is concerned with the work of the Douglas Aircraft group turning out the instruction handbooks for air and ground crews. The importance of the manuals is demonstrated, methods of preparing them are detailed, and the development of the department is reviewed. A review is given on the latest maintenance manual to be released—the C-54A Maintenance Manual. *Douglas Airview*, May, 1943.

Additional Tubing Data Sheets

Revised and new sheets covering digests of Government specifications for aircraft tubing have been issued. It is stated that all essentials covering chemical analysis, mechanical properties, and size tolerances are shown. Sections I-5 through 11 and also section III-50 are replaced by new sheets. A supplementary index sheet gives the outline and page location for each sheet. *Summerill Tubing Company*, Bridgeport, Pa.

Data on Rectifiers

Illustrated catalogue sheets have been issued describing over 50 models of Rectodyne electrical rectifiers. The sheets are designated as No. 300 and No. 301. They contain specifications of Rectodyne rectifiers for furnishing direct current for many uses including aircraft testing and signaling equipment, charging aircraft batteries, and operating d.c. motors, solenoids, and control equipment. *McColpin-Christie Corporation, Ltd.*, Los Angeles, Calif.

Pump Catalogue

In a 32-page bulletin titled *Deming Pump Applications* the various types of Deming pumps available for war and other work are described. The company manufactures centrifugal, rotary, and piston pumps and pumping units. A table of specifications is provided with each type of pump described. Included in the descriptions is one of the model 4.700-G pump for aircraft fueling systems. *The Deming Company*, Salem, O.

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• When discussing the motor for your new product, we suggest that you give careful consideration to the following points:
1. What suppliers have had the most experience in the design and manufacture of special application (fractional horsepower) motors?
2. What companies are best qualified to assume complete responsibility for the motor design or will cooperate with our engineering department?
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KENT, OHIO
THOROUGH ENGINEERING is the basic factor behind the successful operation of this aircraft fuel pump motor and many other special application motors we have designed for all types of equipment.
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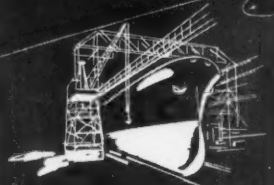

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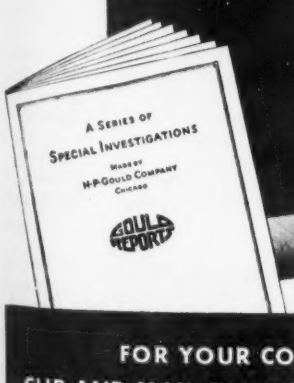

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Engine Fundamentals

What Makes It Fly? Charles Sacton. A series of comments told in a humorous vein explains some of the basic principles of aircraft engines. The details given refer mainly to air resistance, pounds per horsepower, and superchargers. *Douglas Airview*, May, 1943.

Accumulator Design and Service

A 4-page leaflet titled *Proven at the Battlefront* describes the Simmonds accumulator for providing auxiliary hydraulic power for aircraft hydraulic control systems. A cutaway view of the accumulator shows the principles of design and operation. The unit consists of a seamless steel shell or housing, a fully enclosed synthetic rubber bag equipped with a high-pressure air valve assembly, and an aluminum-alloy plug containing especially designed oil discharge holes and equipped with a synthetic rubber seal and a closure cap. The accumulator automatically provides the power required when the main power supply is not operating, or lacks the capacity to do a particular job. A service manual on the accumulator also has been issued, giving the information required for its installation and servicing. *Simmonds Aerocessories, Inc.*, New York.

Engine Flight Test Section

Final Exam. This article deals with the activities of the Flight Test Section of the Wright Aeronautical Corporation. It describes how the following characteristics of aircraft engines are tested under critical conditions: carburetion, cooling, lubrication, fuel system, ignition, the propeller, and vibration. The use of photography to supplement the judgment of pilots and observers in test flights is reported and the qualifications of an able test pilot are listed. As designated in this article, the objectives of this department are to test the flight characteristics of new engines and to solve the problems that arise when an engine is installed. *Trade Winds*, June, 1943.

Bulletins on Precision Machinery

Three bulletins have been issued containing information and data on Taylor precision drilling machinery, static universal balancing machines, and hydraulic dynamometers. Drilling machines with capacities up to $^{5}/_{8}$-in. diameter are described. The dynamometer is of the power absorption type and is designed for testing aircraft and other types of engines. Static balancing machines of various types and capacities are listed and described. *Taylor Manufacturing Company*, Milwaukee, Wis.

Electronics at Work

Electronic applications in industry, in the war, in medicine, and in the home are illustrated and described in a new 44-page booklet titled *Electronics at Work*.

A new type wrench made of lightweight Plexiglas and designed for assembly operations on radio equipment used by the U.S. Navy Bureau of Ships.

A few typical applications shown are: resistance welding control for sewing plane parts together at 1,800 stitches per min.; cathode-ray oscillograph for electrical circuit and lightning phenomena analysis at speeds of $^{1}/_{100}$ of a millionth of a sec.; high-frequency induction heating units for plastic molding; tin reflowing and surface hardening; ignitron rectifiers for converting alternating to direct current in aluminum and magnesium production; industrial x-ray units for "inside" inspection of vital metal parts; precipitron for removing air-borne dust particles as small as $^{1}/_{250,000}$ of an in.; testing vibration fatigue in aircraft and engine parts; and controlling seadrome lights.

Various types of electronic tubes—key units of every electronic device—for such applications as industrial control, diathermy, power conversion, x-ray, and radio are illustrated and the primary use of each identified.

An educational motion picture bearing the same title explains the six basic functions of electronic tubes and shows how each type of tube is used in some of the latest industrial and military applications. Animated drawings showing tube construction are used to explain how the cathode, anode, and grid elements rectify, amplify, generate, control, and transform light into electric current and transform electric current into light. Precipitron, radio and radiotelephony, high-frequency induction heating, resistance welding control, television, and industrial and medical x-ray are a few of the electronic devices that are illustrated and described to show how the tubes perform in the various applications. The film is loaned free for showing at war plants and engineering and technical societies. *Westinghouse Electric & Manufacturing Company.*

Cargo Plane Plant

The Wooden Giant. The construction of the new Chicago plant of the Douglas Aircraft Company is described. It is stated that this plant, which soon will be in production, is the largest exclusive cargo plane manufacturing plant in the world. It is designed and tooled for the sole production of the C-54 Skymaster four-engined transport plane. The plant has its own airfield and airport and a railway system with 9 miles of track. Through the almost sole use of wood in the plant's construction, 30,000 tons of steel have been diverted to the manufacture of war products. By employing laminated wood columns throughout, the use of large-dimension timber was avoided. Wood trusses 150 ft. long, combined with the columns and joined with metal connectors by a recently developed technique, equalize the stress and permit wider spans than were considered possible a few years ago. *Douglas Airview*, May, 1943.

Couplings and Hose Fittings

A standard file containing information on Aeroquip products has been published. It is designated by the company as No. 2530-A and contains dimensional specifications, drawings, illustrations, charts, and other data on Aeroquip self-sealing couplings, hose fittings, and hose lines. The file is designed for the addition of new and revised sheets issued in the future. *Aeroquip Corporation*, Jackson, Mich.

Marine Aviation

Devil Dogs with Wings. The history of U.S. Marine Aviation is briefly outlined. Several noted Marine pilots are mentioned—from Cunningham, the first Marine flier, to Foss, flying Marine of World War II. *Trade Winds*, June, 1943.

Consolidated Catalogue Supplement

The diversified products of The Weatherhead Company are shown together in one publication for the first time in a new catalogue supplement, published for the convenience of enginering, production, designing, and purchasing departments.

The 8-page supplement shows a cross section of five lines of products. Each division is represented by a condensation of its regular catalogue. Weatherhead's Aviation Division has a showing of aviation tube, pipe, universal, and hose fittings. Sixty-nine representative automotive and industrial tube and pipe fittings and other products are illustrated in the section devoted to them. The valves, fittings, and accessories manufactured for the refrigeration industry are described in the refrigeration section. A page is devoted to the company's exclusive Ermeto fittings, and space is given to marine products. *The Weatherhead Company*, Cleveland, O.

Propeller Damage

Metal Props Stand Up Under Plane's Own Gun Fire. A statement on the sturdiness of aluminum-alloy blades when sometimes damaged by bullets from the plane's own guns. The advantages of metal propellers in danger of damage from the plane's guns are

Stalingrad Story

Your children's children will thrill to the story of Stalingrad.

—of the besieged, battered, hopeless city that was saved by white hooded infantrymen crawling on their bellies in swirling wastes of snow.

—saved by heroic ground forces whose magnificent air support never failed them.

Bell Airacobras, roaring over the Stalingrad front, gave wings to artillery. Above the masses of men and tanks locked in combat on the ground, they hunted out the enemy's vital spots—blasted them at short range with explosive and armor piercing cannon shells. Providing air support for ground troops is a job the Airacobra does superlatively well.

Here's the significant point. Airacobras were there in force when they were needed. We're able to deliver planes for action now *when they're needed* in this global war, because we started early enough, planned well enough and pushed production hard enough.

After victory we'll be telling you about new Bell planes, planes of peace. What will they be like? Well, they'll be designed, engineered and built by an organization that makes a habit of aviation pioneering. © Bell Aircraft Corporation, Buffalo and Niagara Falls, New York.

Airacobras for victory—

FUTURE PLANES FOR PEACE

BELL *Aircraft*

PACEMAKER OF AVIATION PROGRESS

HISTORY'S *Greatest* MASS FLIGHT

Not until the war is over and the need for secrecy is ended can the full importance of this achievement be realized. All that can be told today is that a large number of giant Curtiss Commando Transports in mass flight have spanned 15,000 miles of ocean and the land of three continents to complete the longest mass flight in history.

From an unrevealed starting point in the continental United States, they delivered without incident, *ninety tons* of cargo and a large group of military personnel in the time of *four and one half days.*

We salute the pilots, the crew and the ground organization of the Army Air Forces and Air Transport Command whose excellent performance made this flight possible. We, of Curtiss-Wright, know that this is but the beginning of a history making epic which will again prove the dependability, serviceability and cargo capacity of the Curtiss Commando.

CURTISS-WRIGHT
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AIRPLANE DIVISION

Member: Aircraft War Production Council, East Coast, Inc.

FIRST
Since the Birth of Aviation

CURTISS *Commando*

FOR CARGO AND COMMERCE

indicated. *The Bee-Hive*, April–May, 1943.

Aircraft-Engine Production

Because circumstances make it impossible for most visitors to undertake a tour of the Wright plant, the methods employed in the manufacture of Wright aircraft engines as revealed by a tour of the plant are presented in a 34-page illustrated book titled *The Power House of Aviation*. Highlights of operations in the laboratories, machine shops, and foundries are illustrated and described. Methods of assembly-line production are disclosed. It is explained that 80,000 operations are involved in the production of the more than 8,000 parts that make up one type of engine. Included in the book are sections covering methods of laboratory control, the magnesium foundry, the casting of cylinder heads, the machining of cylinder heads and barrels, the joining and finishing of the heads and barrels, assembly line and inspection operations, the building of the power section, the manufacture of the crankshafts, connecting rods and pistons, gear making, final engine assembly, and testing. *Wright Aeronautical Corporation.*

Testing for Aircraft Improvements

Experimental Flight. D. D. Shomer. A continuation of an article on the Experimental Flight Department of Lockheed Aircraft Corporation. Dealing mainly with test installations for the conduct of the work, this installment features the automatic observer. The purpose and operation of this device are explained. A report is included also on the results of the Lockheed Constellation's first flight test. *The Lockheed-Vega Aircraftsman*, May, 1943.

Clutch Head Screws

United clutch head screws, which can be operated with either an assembly bit or a standard screwdriver, are described in a 10-page catalogue. It is explained that the fact the screws can be operated with a screwdriver is important to the man in the field. Clutch head screws eliminate driver slippage and have other advantages, which are outlined. The center pivot assembly bit built for operating these clutch head screws is also described. *United Screw and Bolt Corporation*, Chicago, Ill.

Air Transport by the U.S. Navy

*Anything * Anywhere.* With the Naval Air Transport Serivce as the subject of this article, the varied kinds of cargo flown by N.A.T.S. are surveyed. The development of the service is outlined briefly, and its task of improving techniques for handling air tonnage is indicated. *Trade Winds*, June, 1943.

Needle Bearing Catalogue

A 7-page catalogue furnishes information on all types and sizes of Torrington needle bearings. A list of engineering revisions applicable to needle rollers has also been issued. These revisions apply to material previously published in Torrington Company Catalogues No. 30 and 31, pages 4 to 9, and Bantam Bearings Corporation Catalogue No. 14, pages 18 to 21. *The Torrington Company*, Torrington, Conn.

Airplane Tire Manual

This illustrated manual of General airplane tires and equipment contains 64 pages. Sections cover laboratory testing, outstanding features of General airplane tires and tubes, and tables of tire data, wheel sizes, and rim dimensions. Other sections are devoted to wheel and brake design testing and servicing, accessories and rubber parts, and the service and maintenance of General tires. *The General Tire and Rubber Company*, Akron, O.

Catalogue PV-1

Vega Illustrated Parts Catalogs. Eleanor Dahl. An account of how the first illustrated parts catalogue made up in accordance with new Army-Navy specifications is being produced at Vega Aircraft Corporation. Working methods of compilation and illustration are outlined and some of the problems involved in making up the volume are observed. It is reported that each illustration will appear opposite its data page. *The Lockheed-Vega Aircraftsman*, May, 1943.

Hydraulic Control

The Sperry Exactor hydraulic control for the operation of aircraft, industrial, and marine equipment is described in an 8-page bulletin. Sectional illustrations and drawings show the design of this hydraulic remote-control system that incorporates a transmitter and receiver connected by a single tube. Applications of the system are illustrated and described. The general dimensions of the transmitter and receiver are given. *Sperry Products, Inc.*, Hoboken, N.J.

S.A.E. Aeronautical Standards

Revised sheets have been issued for inclusion in the S.A.E. Aeronautical Standards files. They include AS41A, single rotation propeller shaft ends; AS-91, dual-rotation propeller shaft ends; AS126, taper type No. 0 propeller shaft ends; AS127, flanged type propeller type ends, No. 1, 2, 3; AS128, flanged spline type propeller hubs, No. $7^1/_2$; flanged spline type propeller hubs No. 10; and ARP142, stud fits and tolerances for steel in aluminum or magnesium alloys. *Society of Automotive Engineers, Inc.*

Safety Manual

A safety manual containing regulations designed to minimize and eliminate employee hazards has been issued. The first section of the book is devoted to general regulations for the protection of employees. In the second section specific regulations are given for employees operating machine tools and for those working in the many other departments connected with the manufacture of aircraft. Also included in the manual are handy reference tables covering metric equivalents, decimal equivalents of fractions, drill and drill rod sizes, United States standard gauge for sheet and plate iron and steel, basic thread dimensions and tap drill sizes, and conversion equivalents. *Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation.*

Development of Naval Aviation

Naval Aviation Then and Now. Highlights in the history of U.S. Naval Aviation are traced from 1908. The article contains some comparative figures on the size of the Naval Air Force at various times. Emphasis is placed upon the adoption of air-cooled engines for the main types of operational naval airplanes. Among the Navy planes briefly described are the Douglas SBD Dauntless and the Grumman TRF Avenger. *Trade Winds*, June, 1943.

National Aircraft Standards

Revised sheets have been issued for insertion in the National Aircraft Standards files. They include sheets NAS 2 on lubrication fittings, NAS 23 on plane tank straps for terminals, and NAS 29 on strap assemblies. *National Aircraft Standards Committee.*

Engine Overhaul Manual

An overhaul manual covering Jacobs aircraft-engine models L-4MB and L-6MB has been published. It contains 123 pages in addition to a number of large drawings and a set of service bulletins in the back of the section of the loose-leaf binder. Information contained in the manual includes the removal of the engine from the airplane to the shipping case; disassembly of the engine into major subassemblies; cleaning; inspection; repair, replacement, and assembly; final assembly; the run-in of engines after overhaul; and the preparation of engines for storage. There are tables of limits for use in conjunction with charts that contain reference numbers indicating the location of fits and clearances. In addition to many drawings, the manual contains a number of photographs of parts and assemblies.

A second manual contains instructions for the operation and maintenance of these Jacobs engine models. Included in this manual are sections covering fuel and lubrication; operating instructions; inspection, maintenance, and engine checks; engine troubles; removal, repair, and assembly of cylinders; and preparation for storage. Charts of engine performance and of absolute dry manifold pressure are furnished, in addition to drawings and specifications.

A parts catalogue for the Jacobs Model L-4MB engine also has been published. *Jacobs Aircraft Engine Company*, Pottstown, Pa.

They work together better . . .
because they can talk together

Into the valley
Of death
Rumble
The enemy tanks . . .

Through the distant pass
They careen
Unaware that
The self-propelled 155's
Have out-maneuvered them
And lie in ambush . . .

Overhead
A lone plane circles
Ominously
Like an eagle
Waiting for the kill . . .

Suddenly it comes!

* * *

A few words
Flash

From the hovering scout plane
To the tense gun crews
And it's all over
But the shooting . . .

Trapped in the gorge
Outranged by the tank destroyers
This marauding land fleet
Will prowl no more.

* * *

Today modern radio equipment
Designed and manufactured
By I.T.&T. associate companies
Is helping Uncle Sam's fighting forces
Work together
On land, sea, and in the air . . .

Tomorrow the broad experience
Of I.T.&T.
In the field of communications
Will help men build
A better world

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION *67 Broad St., New York, N.Y.*

I T&T

Manufacturing Associate:
FEDERAL TELEPHONE AND RADIO CORPORATION

Growth and Policies of an Aircraft Builder

Wings for the Stars. The history of the Lockheed and Vega Aircraft corporations is reviewed briefly. In picturing the great growth of the companies, men who have been instrumental in its development are mentioned. Some of the companies' policies are also noted. *Lockheed-Vega Aircraftsman*, June, 1943.

Fuel Data Book

A booklet titled *Background Data on 100 Octane Gasoline* traces the history of the development of this fuel and describes its manufacture. The potentialities of 100-octane gasoline for war and peace and the economic and strategic choices related to it are discussed. Following the text, which covers 21 pages, are: a list of the companies manufacturing 100-octane gasoline, some data on the decrease in aircraft-engine weight from 1918 to 1941, and a chronology. *The Standard Oil Company*, (N.J.).

Twisting Parachute Cords

Parachutes for Paratroops. An article describing Atwood twisters—machines used for the production of the Nylon sewing thread and cord used in making parachutes for the Army. The heart of these machines is a Fafnir ball bearing-equipped spiral bevel gear unit for controlling the twist of the Nylon. Reasons why Atwood chose Fafnir ball bearings for the shafts of the twist unit are set forth. *The Dragon*, June, 1943.

Flight Instructors' School

Postgraduate Air College. An account of the Central Instructors School at Randolph Field gives information on the purpose, curriculum, instructors, and classroom and operational techniques. This postgraduate flight training institution was established to feed Army air training schools with technically expert teachers. It prepares civilian pilots to become primary flight instructors and commissioned fliers to teach twin- and single-engined basic and advanced flying. *The Pegasus*, July, 1943.

Steel Joiners

They Built Jigs but Produce Precision, Speed and Economy. This article is concerned with the work of Beech Aircraft's jig-building department. It presents some brief details on the functions of jigs, different kinds of jigs, and the construction of jigs. *The Beech Log*, June 18, 1943.

Vibration Insulators

A bulletin on Duflex vibration insulators has been issued. The characteristics and applications of these insulators are described. Duflex vibration insulators, which are commonly called "mounts," are designed for the vibration insulation of instruments and apparatus for aircraft, mobile military equipment, and ships. It is explained that the different sizes and capacities conform to Government specifications and are, therefore, interchangeable with other approved mounts. A section of the bulletin deals with the mathematics of vibration insulation. Load-deflection curves for the different series of Duflex mountings are furnished. Illustrations, sectional drawings, and specifications of the different mounts are provided. *Harris Products Company*, Cleveland, O.

Aircraft-Engine Maintenance

Instructions for the operation and maintenance of Kinner R-52, R-55, and R-53 aircraft engines are furnished in the form of a loose-leaf manual. Sections are devoted to the general specifications of the engines, operation, periodical inspection and servicing, overhauling, and fuel requirements. There are limits and lubrication charts and also tables of limits for the parts of each model. Service information on such accessories as magnetos, carburetors, and spark plugs is also given. Photographs of each type of engine are shown and an engine-performance chart is provided in the opening section of the manual. *Kinner Motors, Inc.*, Glendale, Calif.

Heat-Treating for Dies

A description of the complicated heat-treating operations employed in the manufacture of a particular die used for casting aluminum aircraft parts. The die is made up of four pieces—the body and a three section ring. It is explained that none of the controlled-atmosphere furnaces were large enough to handle the die, so one was improvised with a retort furnace. Details of preheating and other operations used in the manufacture of this special die are outlined. *Heat Treating Hints*, Vol. 5, No. 2.

Welding Technique

Highlights in Welding Common Metals. To provide welding operators with a ready means of comparing and learning to recognize the differences and similarities of welds in different metals, a table is provided covering the more important characteristics of fusion welds in most of the metals commonly encountered in the average welding shop. The table is intended to show the highlights of the subject, but high-alloy steels are omitted because they are so numerous and their welding characteristics are so varied. *Oxy-Acetylene Tips*, July, 1943.

The Klystron Tube

Three Men and Tube. The story of how the Klystron tube was developed and of the three men responsible for its development. Because of military restrictions, details of the device's present and future use are not included. The Klystron is defined as an electronic tube that produces the extremely short wave lengths needed to make radar effective. *The Sperryscope*, July, 1943.

(*Continued from page 137*)

list of the officers and committee members, a tabulation of the number and classes of the members, and an abbreviated report of the annual general meeting of the Society. A special general meeting is also reported, and the awards of medals, honors, and scholarships are listed. A section on the finances of the Society includes detailed statements of income and expenditures, the balance sheet for December 31, 1942, and financial statements of Aeronautical Trusts Limited. *The Journal of The Royal Aeronautical Society*, May, 1943, pages 144–158.

Aircraft and Engine Review 1943. *Commercial Aviation's* fourth annual directory is divided into six parts. The first section constitutes a survey of American civil aircraft; the second, American military aircraft; the third, British and Canadian military aircraft; the fourth, German military aircraft; the fifth, Japanese military aircraft; the sixth, Italian fighting aircraft; the seventh, Russian military aircraft; the eighth, American and British gliders; the ninth, American aircraft engines, and the tenth, British aircraft engines. Photographs supplement the listed specifications. *Commercial Aviation*, May, 1943, pages 40–44, 46, 48, 50, 53, 54, and even-numbered pages through 122, 169 illus.

Directory of Sources of Supply for the Aircraft Industry in Canada. This annual directory lists the names and addresses of suppliers of aircraft, engines, parts, supplies, and equipment, as well as their agents. It is classified alphabetically under headings covering the materials and supplies involved. The names and addresses of Canadian agents for manufacturers located outside of Canada are appended to the listings of the manufacturers. In cases where there are more than two branches or agents, these are catalogued at the end of the directory. *Canadian Aviation*, June 1943, pages 119–182.

Use the Old Oil . . . . Again! Dean M. Cleaveland. The recovery of coolants, solvents, and lubricants as carried out at the Bendix plants is described. It is stated that at the South Bend plant the recovery system shows a monthly return of 60 per cent on the investment. *Wings*, June, 1943, pages 530, 531, 3 illus.

Corsair...ALTITUDE

With its highly supercharged 2,000-horsepower engine, the Navy's Vought Corsair operates at extremely high altitudes. From this commanding position, Corsair pilots are pouncing on the enemy with deadly effect.

CHANCE VOUGHT AIRCRAFT

STRATFORD, CONNECTICUT

ONE OF THE FOUR DIVISIONS OF UNITED AIRCRAFT CORPORATION

From the Industry

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Electrode Index for Comparison Purposes

A new electrode comparison chart is intended to help simplify the buying of competitive welding electrodes. The chart details the principal A.W.S. and A.S.T.M. electrode classifications and indicates which electrodes produced by 20 leading manufacturers meet the different requirements.

The chart can be used to determine what brands of electrodes fall within a specified A.W.S. and A.S.T.M. category, as well as to learn what alternate brands might be used successfully should a specified electrode not be available. Air Reduction Company, New York, N.Y.

New Hose Clamp

The Aircraft Standard Parts Company has introduced a new line of "Aero-Seal" Hose Clamps in 14 sizes from $^3/_4$ to 4 in. inside hose diameter. The basis of the design was the requirements set forth in Army Air Forces Specification No. 25529.

The Aero-Seal Hose Clamp consists of a $^9/_{16}$-in. tempered steel band punched with holes corresponding to the teeth of a worm gear. These holes mesh with a worm in the housing welded to the fixed end of the band. The worm is turned by a screw driver, and the screw-head on the worm is fitted with a safety cup that prevents the screw driver from slipping and puncturing the hose or damaging other equipment.

The belt-like tightening action produces a uniform tangential pull that does not distort the pipe and results in a leakless clamping action. By backing up the screw, the free end of the band comes out of the housing, and the clamp may then be sprung open and slipped over the hose in place on the pipe. Likewise, a clamp can be easily removed in the same manner.

While a line of 14 sizes is provided to cover hose from $^3/_4$- to 4-in. nominal sizes, it is possible for six sizes of the Aero-Seal Hose Clamp to cover the same range. The band has a total take-up of 3 in. (2 and $2^1/_2$ in. on the smaller sizes) and can be tightened considerably below its nominal size by letting the free end of the band come through the housing a couple of inches. The superfluous band is not a disadvantage in most cases.

Aero-Seal Hose Clamps are self-locking as a result of the worm and worm gear action and are claimed to be virtually impossible to loosen even with severe vibration as long as the band is under tension. Lock wires are not necessary. Aircraft Standard Parts Company, Rockford, Ill.

Vibration Fatigue Testing Machine

The addition of the Model 100 to the maker's line of vibration fatigue testing machines has been announced. The new unit will handle parts or assemblies up to 100 lbs., which are to undergo vibration fatigue tests. The table has an area of 15 by 18 in. and has 115 tapped holes for bolting on objects. The table movement is horizontal.

The frequency is adjustable while the machine is running, from 10 to 60 cycles per sec. (600 to 3,600 vibrations per min.) and is recorded on an electric tachometer. Displacement, from 0 to 0.125 in. (adjustable) covers the full range encountered by parts subjected to vibration in actual service. The maximum capacity is 23 *g*.

Base area of the unit is 24 by 42 in. Weight is 550 lbs. A $1^1/_2$-hp. motor supplies power. Eyebolts in the base permit handling the unit with a shop hoist or crane.

The Model 100 is designed for use in laboratories or inspection departments to test fabricated air-frame and aircraft-engine parts, navigation instruments, radio and electronic equipment, molded plastic parts, foundry cores to determine strength, packaging to determine resistance to vibration, and a variety of other parts, materials, and chemicals, to determine the effects of vibration. All-American Tool & Manufacturing Company, Chicago, Ill.

A.C. Welder

The Ampac "200" a.c. welder is designed to give automatically correct voltage for the continuous range of currents available, rather than using an almost constant voltage at all current settings. This adjustment not only makes welding easy at low currents because of the high striking voltage but is claimed to save power when welding at high currents because the voltage is low.

Other special design and operating features include the new integrated reactor-transformer construction that provides high voltage for easy welding at low currents; active duty from every line of flux achieved by reactor coils that surround the variable air gap; and simplified construction using fewer working parts, cutting maintenance down to routine lubrication twice a year.

Advantages claimed by the maker are the lower original cost, less power consumption, and easier welding. The first two are the advantages of a static machine over a rotating machine, while easier and faster welding results from the elimination of "arc-blow." With no arc magnetism to cause the arc to wander and weave, it is stated that welding becomes easier, especially for inexperienced welders.

Increased welding capacity in one machine is also claimed because of the wide range of current, which is from 30 to 250 amp. There is no need to switch welders for different jobs because it handles rods $^1/_{16}$ to $^1/_4$ in. in size, for thin sheets or heavier plates. Most d.c. rods as well as all a.c. rods can be used. Allis-Chalmers Manufacturing Company.

Aircraft Fasteners Division

The American Institute of Bolt, Nut and Rivet Manufacturers has authorized the setting up of an Aircraft Fasteners Division to function for them in aircraft products in the same general way as carried on heretofore in connection with other products of the industry.

In the last few months there has been a great increase in the number of matters relative to aircraft fasteners that have been taken up with the organization by various interests. Requests for information or cooperation have come from the Interdepartmental Screw Thread Committee, Army-Navy Aeronautical Board, Wright Field, Army and Navy Air units, Society of Automotive Engineers, and the War Production Board, as well as many aircraft manufacturers.

The questions that have come up from time to time have been in connection with steels, cadmium plating, plating tolerances, decarburization, standards in dimensions and tolerances, sources of supply, etc. This has come about in a natural way as a result of the activities

UNIONAIR Junction Box Assemblies are produced under a single responsibility — ours.

Aircraft Manufacturers, bending every effort to increase aircraft production, have turned to Unionair in increasing numbers for such assemblies. We regard this as a compliment to our strict standards of quality, and as a mark of confidence in Unionair Responsibility.

This responsibility is an obligation which we do not wish to shift in whole or in part. In all types of assemblies, from the simple Fuse Box, pictured above, to a complex wired Control Box, Unionair's desire to assume full responsibility for the complete unit is your assurance of our ability to perform.

UNIONAIR

Makers of Junction Boxes and Assemblies
Conduit Fittings —Hydraulic Fittings

UNION AIRCRAFT PRODUCTS CORP.
NEW YORK

of the institute, representing the industry in a broad way in other fields over a term of years, and as a result of the fact that most of its members are now engaged in the manufacture of fasteners for aircraft. The new division will endeavor to answer these and other questions. American Institute of Bolt, Nut and Rivet Manufacturers, Cleveland, O.

Control Motors

Barber-Colman control motors have been designed for aircraft service. They are used for the control of dampers, in governing cabin temperatures, the flow of air through supercharging and intercooling equipment, and engine cowl flaps. They are also used to drive valve mechanisms on various types of lines carrying gasoline, water, steam, antifreeze mixtures, etc., and for the operation of gasoline dump valves and cabin pressure regulating valves.

The motors are intended for low-temperature, high-altitude operation. They are housed in aluminum cases. All gears are machine-cut, hardened, and packed with a low-temperature lubricant. Totally enclosed tamper-proof limit switches are set for 90° or 180° rotation. Control motors are available with or without mounting brackets and with AN-type connector plug mounted on end.

Motors are available for positive, floating, or proportioning control; as a unit of the Barber-Colman Micro system; or for step control by manual or automatic means and for remote position indication. Barber-Colman Company, Rockford, Ill.

Machine-Gun Recoil Damper

The Bell Machine Gun Adapter was developed by engineers of Bell Aircraft in cooperation with aircraft ordnance experts of the Army Air Forces and the Navy Bureau of Ordnance nearly 5 years ago. It is a portable, lightweight cradle consisting of two steel tubes and a hydraulic absorption unit and is attached to a 0.50-caliber aircraft machine gun by two bolts. It adds less than an inch to the overall dimensions of a 0.50-caliber gun and adds but 3 lbs. to the weight when conventionally mounted. The adapter enables the gunner to train his sights on the target and keep them there and, at the same time, reduces the fatigue strain on the gunner and the strength of structure requirements for mounting the gun in the airplane.

The success of the 0.50-caliber adapter was followed by the development of a mount for 0.30-caliber guns. This type substitutes a combination of springs, air cushion, and friction discs for the hydraulic unit. At present 0.50- and 0.30-caliber twin gun mounts are being built in addition to adapters for single guns of these calibers.

Bell adapters are in use on such aircraft as the Flying Fortress, Liberator, Mitchell, and Marauder bombers of the Army, and on Navy Douglas dive bombers, torpedo planes, and Con-

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From the deck of a ship a plane is shot into the air ...catapulted by a giant "sling" that imposes a load of about one million pounds on the Hyatt Roller Bearings in its mechanism.

What a wallop!

And what a bearing...that possesses the necessary design, precision and toughness to handle such load extremes!

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Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

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Using...IRC Resistor Elements

ANOTHER IRC DEVELOPMENT

For millions with impaired hearing a new avenue of hope was opened when scientists applied to this field the amplification of sound by means of the vacuum tube. From that point on, manufacturers directed their efforts toward instruments combining increased effectiveness with reduction in both size and weight.... Because volume and tone control plays an extremely important role in these small amplifying sets, it is only natural that I R C should have been consulted in the design of this sensitive part. The tiny Volume Control units used by many manufacturers not only employ special Resistance Elements as developed by I R C but also utilize the multi-finger contact and spiral clock-spring connector ideas originated and perfected by I R C. Marvels of compactness and efficiency, these midget controls constitute still another tribute to the ingenuity of I R C's engineering staff.... Perhaps you, too, are faced with a problem requiring expert resistance counsel. If so, we welcome your inquiry and will be glad to apply our research facilities toward its solution.

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solidated and Martin patrol bombers as well as PT motor torpedo boats. In addition, they are used on British and other United Nations combat aircraft.

The present Bell machine gun mount for 0.50-caliber guns is the direct outgrowth of efforts to dissipate the recoil forces of 0.50-caliber flexible machine guns when they were first installed several years ago in the twin-engined, twin-cannon Bell Airacuda. Early experiments dealt with mounting the gun on a tubular frame on each side of which was attached a standard type automobile shock absorber. The arms of the shock absorber were then attached to the gun. The experiment not only worked but provided sufficient basic information for the design of the small, light shock units which, with further refinements, are now in volume production and widespread use in the combat zones. Bell Aircraft Corporation.

Vertical Bench Milling Machine

An improved vertical bench milling machine with a quick-change attachment for horizontal milling is announced. The $2^1/_2$-in. diameter arm supporting the spindlehead is clamped rigidly to the column and can be readily adjusted to rotate the spindle 60° either side of center. The entire head is easily removable and may be replaced with an enclosed horizontal milling attachment. Thus, a variety of jobs such as precision diemaking, diesinking, profiling, jig boring, key slotting, etc., can be handled without tieing up a large machine.

This two-way machine stands 30 in. high, has a precision ground table 6 by 14 in., with three T slots $^3/_8$ in., 2-in. centers. Micrometer adjustments for the table movements are operated by convenient splined disengageable hand cranks, while graduated dials reading in thousandths of an inch make resetting a simple process.

Proper tension on the V-belt at all times is obtained by a floating motor mount, and rapid changes of the four spindle speeds (450, 850, 1,400 and 2,100 r.p.m.) are thus possible without the use of tools. The spindle has a No. 2 Morse Taper. The milling machine is powered with a $^1/_3$-hp. motor. Benchmaster Tool Company, Los Angeles, Calif.

Emergency Radio Transmitter

An easily operated precision emergency radio transmitter that automatically sends out SOS signals is in widespread use by flying crews of the Army Air Forces.

Carried as emergency equipment by crews on ocean-going missions, the waterproof transmitter, which together with accessories weighs only 33 lbs., is capable of sending an automatic SOS over an effective range of 100,000 square miles. No experience or radio knowledge is necessary to use the equipment. Rotation of a hand crank operates a keying device that automatically spells out the SOS and also produces the necessary power through a generator. The voltage output of the generator, because of a regulator, remains constant, despite wide variations in cranking speed.

The device is pretuned to the international distress frequency of 500 kilocycles. Some idea of the instrument's precision operation may be gained from the fact that its signals will trip the carefully tuned automatic shore alarm stations.

Controls on the front panel of the transmitter enable the user, if desired, to operate the set manually with a key for sending messages in code. An attachable light may also be used to signal rescue parties or for illumination.

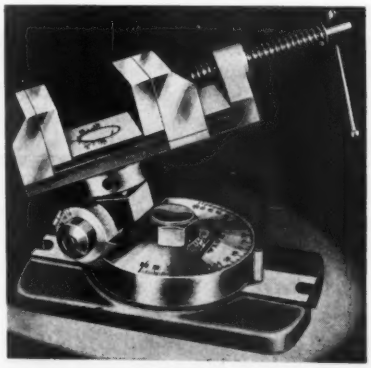
To meet the antenna problem, a collapsible kit and a neoprene balloon were developed to remain aloft under adverse weather conditions. The kite is flown when a good wind is available. For calmer weather the balloon may be lifted with hydrogen gas, created by immersing a simple hydrogen generator in the water. Best results are obtained with the kite or balloon at about a 300-ft. altitude.

A kite string of glass yarn is used with the box kite that carries aloft the antenna. Glass yarn is used as the kite string because of its strength in proportion to its weight and because it will not rot or otherwise deteriorate from the effects of salt water, tropic sunlight, rain, or dampness. The yarn is twisted and plied from continuous-filament glass fibers that can be drawn to indefinite lengths, measurable in miles.

The instrument and accessories are packed in a buoyant, water-resistant bag that is colored a vivid yellow so that it may be easily discernible in the water. The bag contains the transmitter, kite, two deflated balloons in sealed cans, two hydrogen generators, two spare reels of antenna wire, and a signal light. Instructions, in addition to the telegraphic alphabet, are imprinted on the top of the instrument. Bendix Aviation, Ltd., Los Angeles, Calif.

Drive Wheel Movement Vise

The Hilco All-Angle "Driv-Wheel Movement" Vise has three accurate and legible protractor dials for horizontal, vertical, and diagonal settings. It was designed and engineered by the industrial engineering firm of Melvin Douglas & Associates, Chicago.



The Hilco all-angle drive wheel movement vise.

Features include a patented drive wheel motion that gives $2^3/_4$-in. lateral clearance; double swivel construction that permits any horizontal position; right-angle clearance that allows perpendicular position without base obstruction; positive horizontal setting for highest 180° accuracy; elimination of excess weight and improved construction that make for easy handling by men or women workers.

The Hilco All-Angle Vise is recommended by the makers for grinders, drill presses, milling machines, magnetic chucks, other machine tools, and bench use. It is especially adapted for the Hilco Universal Cutter Grinder. The Berco Manufacturing Company, Chicago, Ill.

Schoolhouse on Wings

Fitted out as an aerial classroom, a Boeing Flying Fortress has been placed in service for specialized pilot training by the Second Army Air Forces in conjunction with the Boeing Aircraft Company. The new training craft, believed to be the first of its kind, is being used to bring to Army student pilots the latest engineering and operational data developed by the aircraft firm's flight research engineers.

The program, which is indicative of the cooperation between aircraft manufacturers and combat forces, supplements the Boeing field engineering service and the Flying Fortress school. The field service consists of company engineers, stationed in war theaters throughout the world, who study the performance of Boeing Flying Fortresses in action and who act as consultants on their repair, maintenance, and operation. The Flying Fortress school, located in Seattle adjacent to the Boeing plant, provides mechanical training to Army personnel who are to serve as ground crews on the fighting fronts.

Originally conceived by the late Eddie Allen, the new method of flight training is confined largely to advanced heavy-bomber students, although many regular Army flight instructors attend classes for purposes of orientation. Classroom discussions are held prior to actual flight demonstrations in the renovated Flying Fortress.

The main purpose of the program is to acquaint pilots with methods whereby the highest possible operating efficiency and flight range may be obtained from the engines. This involves coordinating many factors, such as fuel mixture, air speed, turbosupercharger pressure, engine speed, and altitude. The pilots are also shown how Flying Fortress bombers will perform under various circumstances. The students are given an opportunity to operate the ship's controls in the face of simulated emergencies.

Specialized training in the capabilities of the Flying Fortress are given particular emphasis—how slow they will fly without losing altitude, minimum

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take-off and landing distances, maximum gasoline mileage, fastest rate of climb, precision maneuvers, landing approaches, and emergency water-landing methods. Boeing Aircraft Company.

Helmet Head Drill Press

Over 60 models of the Helmet Head drill press are now being offered in one-, two-, three- and four-spindle types; high and slow speed; bench or floor type; slotted or trough table.

Five predetermined speeds allow for every operation. A feature is the new self-centering 30° pressure angle, six-tooth involute spline. The spindle, quill, and spindle pulley are held in permanent and correct alignment.

The quill, longer and larger in diameter, is held by three bearings, permitting long holes to be drilled more accurately.

Tapping machines, designed for the Helmet Head, operate at 3,000 r.p.m. "in" and 6,000 r.p.m. "out." Taps enter every hole centrally without strain. Two sizes are offered. Boice-Crane Company, Toledo, O.

Floating Cam Collar

The Camloc line of high-speed cowl fasteners has been further increased by the addition of the Floating Cam Collar which allows large spotting tolerances. Other cam collars include straight, corner, ear, and bracket models. Rivet-type cam collars are used for interchangeability with other fasteners and where limited edge clearance prevents Camloc's standard single-hole mounting. They are adaptable to metal, plastic, and plywood. All cam collars can be used with both slotted and wing head stud assemblies of the same series. Camloc Fastener Corporation, New York, N. Y.

Improved Rockwell Tester

An improved hardness tester for Rockwell testing in three models, US8, US12 and US16, is announced. The instrument is said to embody a number of features contributing to accuracy of measurement and speed of operation. Among these are a frictionless spindle that provides a correct minor load at all times; zero drag trip that eliminates friction or drag on the loading beam, to insure consistent accuracy of the major load; a dial indicator adjustment affording a convenient, simple means of maintaining accuracy of readings; and a minor load adjustment.

Other features of the instrument are the fully enclosed elevating screw, with self-lubricating oil reservoir, and an adjustable steady rest. The instrument is supplied complete with diamond cone penetrator and steel ball penetrators for Rockwell testing on "C" scale, "B" scale, and most other standard Rockwell scales.

Three anvils are included: a standard $3^1/_2$-in. anvil for large flat bearing surface work; a spot anvil for most standard size pieces and for use with test blocks; and a "V" anvil for testing round cylindric parts. These are in addition to the two smaller "V" anvils that form part of the adjustable steady rest. Clark Instrument, Inc., Dearborn, Mich.

Speeding Aircraft Production with "Visuals"

The development of three-dimensional "Visuals" has brought a new type of artist into the engineering departments of aircraft manufacturers. He is a combination of commercial artist and mechanical draftsman, able to produce, with the aid of a patented drawing paper, mechanical drawings that have a three-dimensional effect.

The perspective drawings or Visuals are redrawn from blueprints for the guidance of workmen who are unable to read blueprints. Each worker can be furnished with a drawing and detailed instructions so that he will have an accurate picture of the job as it will look when it is finished.

While the conventional blueprint cannot be entirely eliminated on those operations where the utmost precision is demanded, it is stated that these Visuals do give the production line sufficiently accurate information to enable workers to produce their work well and rapidly.

There are four basic uses for three-dimensional Visuals. First, preliminary sketches on which both engineers and management can confer with greater speed and greater understanding (errors in design are stated to be more easily detected than in the straight orthographic projection drawings); second, the breakdown of the manufacturing process into its various operations with detailed explanations of the part or parts being produced; third, the illustration of the completed subassemblies which ultimately form the completed airplane; fourth, the production of manuals for the use of pilots and maintenance men. The various parts of the plane and its details of construction are shown graphically in these manuals.

The makers state that Craftint Doubletone Drawing Paper has been adopted by many of the aircraft manufacturers because of the fact that it gives three-dimensional effects with depth and roundness even in the hands of medium-skilled artists.

When Craftint drawings are made on one-ply Doubletone, contact blueprints can be made direct from the original drawing, thus making easy the reproduction of quantities with the least possible loss of time. Craftint Manufacturing Company, Cleveland, O.

Jam Riveting Process

A process of setting rivets, which is adapted to work on difficult warplane parts and is estimated to cut by 40 per cent the number of two-man riveting teams when fully applied to production, has been revealed by one of the aircraft manufacturing plants of Curtiss-Wright Corporation's Airplane Division where the new riveting procedure was developed and is now in use. It is called "jam riveting."

The Curtiss-Wright hand-tool vibrator with adjustable depth timer and hinged yoke.

The new development, which eliminates the "bucker" of the two-man team, combines flexibility and speed in driving warplane rivets and is said to be more effective than the "gang squeezer" method. Besides increasing output, the new method insures more uniform quality of work with less rejections and salvage.

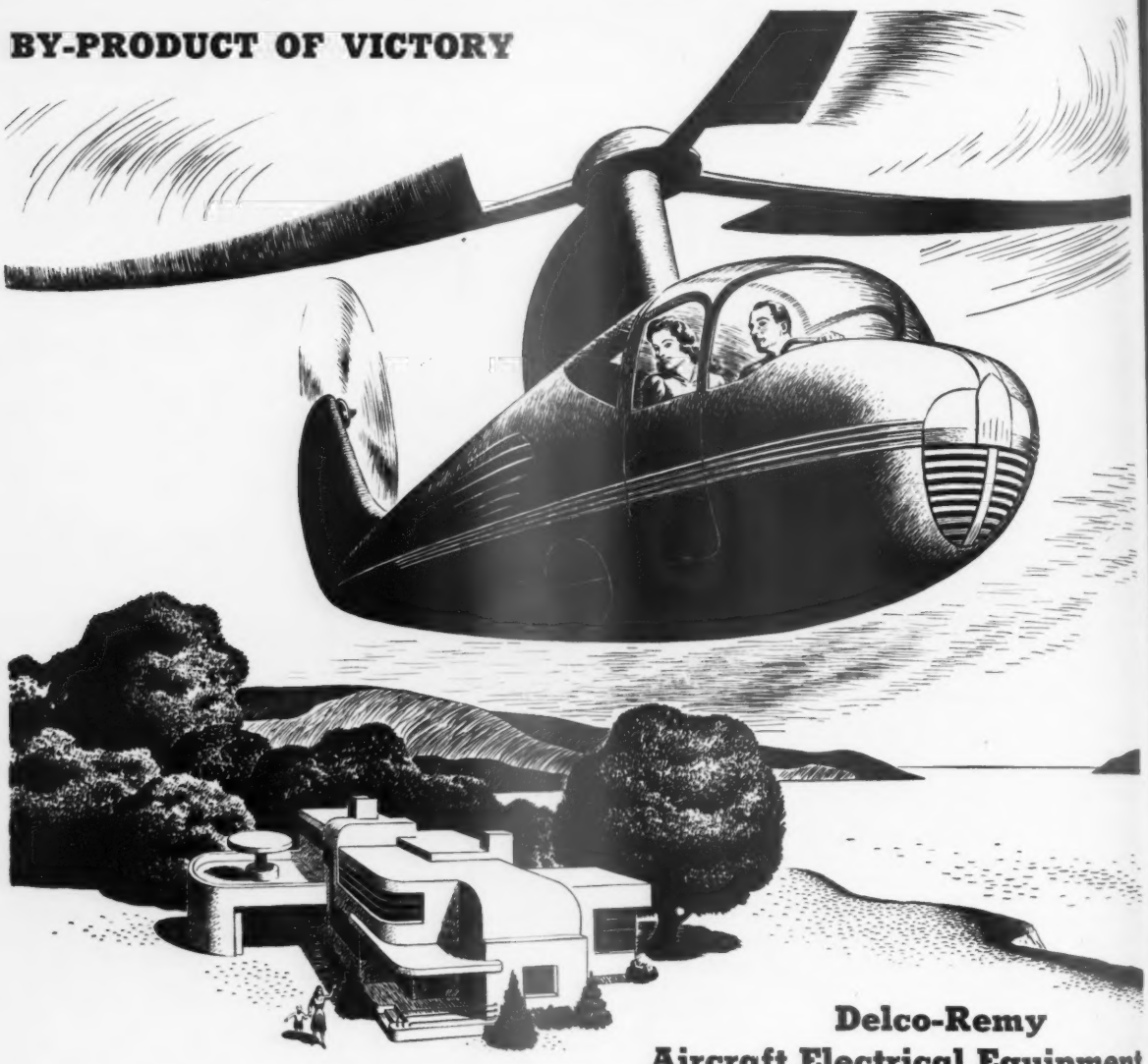
The new tool, to be used in the production of Curtiss Warhawk (P-40) fighters and Curtiss Commando (C-46) military transports, consists of a regular vibrator with attachments so that its action is automatically controlled by the "travel" of the driving set. It was designed to work on curved cowling and other specialized parts where gang or individual "squeezers" cannot operate. One adaptation is a hand-tool vibrator with adjustable depth timer attached to a hinged yoke. The second is a vibrator adapted to a special yoke fabricated from cold-rolled steel and mounted on a pedestal. Both of these tools are easily adjusted for the correct height of the finished rivet and automatically stop when that point has been reached.

The pedestal-mounted vibrator was designed to handle a particularly difficult rivet set problem in the cowl department where it is successfully performing a riveting job that heretofore was almost inaccessible. This tool will handle $^5/_{32}$-in. rivets in spite of the odd-shaped yoke. An added advantage is that the yoke is made entirely of welded cold-rolled steel, which gives a live bucking action as well as conserves strategic material.

The hand tool has sufficient power to head a $^1/_4$-in. rivet with ease, yet it is substantially lighter than an equivalent squeezer and can be easily handled without the aid of a spring balance.

These riveters were conceived by the Buffalo Tool Procurement Department and built for Curtiss-Wright by the Ingersoll-Rand Company, which will manufacture them commercially as "Air Buck Jam Riveters." Curtiss-Wright Corporation.

BY-PRODUCT OF VICTORY



Delco-Remy
Aircraft Electrical Equipment

In the sleek fighters and hard-hitting bombers of America's aircraft production, there is a promise that extends beyond the goal of Victory. It is the promise of an age of flight, when vast new realms of knowledge can be applied to peacetime planes. Delco-Remy aircraft electrical equipment is now meeting the requirements of heavy and medium bombers. In days to come it will serve on commercial planes, while smaller Delco-Remy units will provide electric starting, lighting and ignition on light planes. More than half of Delco-Remy's facilities are today engaged in manufacturing aircraft electrical units, precision parts and products for the aviation industry.

ARMY E NAVY

DELCO-REMY

DIVISION, GENERAL MOTORS CORPORATION

Training Army Mechanics How to Taxi Warplanes

To demonstrate how fast Curtiss Warhawk (P-40) fighters are taxied on the ground and to speed up the training of aircraft mechanics, officials of the U.S. Army Air Forces Training Command School at Camp Curtissair have developed a special "Taxi Trainer" for the instruction of ground crew men in handling new P-40 fighters.

The trainer was built from salvaged Curtiss P-40 parts. Since a Curtiss Warhawk fighter is a single-place plane, a special ream cockpit was built to accommodate the student mechanics and was outfitted with a duplicate set of controls. An intercockpit communications system was installed to allow the instructor to talk with students.

The trainer was designed to save time in teaching Army ground crew men the proper method of taxiing powerful fighter planes with safety, since the mechanics perform a large part of ground piloting in preflight testing, repair, and modification. With its unusual tricycle landing gear, consisting of an added forward nose wheel built especially for this purpose, the trainer cannot be nosed over by too sudden a pressure of its brakes by an inexperienced student. Curtiss-Wright Corporation.

Die Piercing of Metal Stampings in Small Lots

To obtain a high degree of accuracy and still make it possible to have 100 per cent flexibility as to tool changes, keeping the initial cost of the tools at a minimum, the Dayton Rogers Manufacturing Company has recently developed and is now using a new type of punch press known as the "automatic electric." With these piercing presses it is possible to change the hole size and location of holes in a given group of pierced blanks to any size and location required with the minimum cost. These hole sizes in the pierced blanks can be produced in any size from 0.015 to $1^1/_8$ in. progressing by 0.001, and the presses are so arranged that these hole sizes and location of holes can be changed on one group of blanks to another without disturbing the production capacity of the presses.

The presses are made in two sizes with a throat capacity from 12 to 14 in. and a maximum tonnage of 15 tons. The slidestroke is $1^3/_4$ in., with a ram adjustment of 2 in. The presses are provided with a shunt height for die space of 2 to 3 in. Each press is completely self-contained and individually motor-driven and may be plugged into the power line at such locations in the plant as the requirements call for.

The ram movement is carried at the bottom or bolster side of the press, and the punch is on upper section, the punch being stationary in all cases. The ram also carries the die. The flywheel has an electric clutch with automatic releasing brake built into the base of the machine. Each machine is provided with its own working guard, and, when it is necessary for the operator to change the tools, by removing the guard on such operations the guard trips automatically and throws the power switch of the individual press. A special cushion stripping mechanism is carried in the head or on the punch side of the press. These die-piercing presses may be easily grouped together and can be used to an advantage where the work has to be passed from one press to another. Machines may be grouped in circles or in a horseshoe layout, making it easy for the operator to move the work from one machine to the other. The presses may be used in batteries or individually. The automatic trip is so arranged that once the work is in correct point for operation the machine automatically goes through the required working cycle and then is locked out until the next piece is put in correct position, thus eliminating the hazard of requiring the operator to trip the press manually when the work is in correct position. Dayton Rogers Manufacturing Company, Minneapolis, Minn.

Official Data on the Mosquito

The de Havilland Mosquito is in service in several versions, as a day and night bomber, a long-range day and night fighter, intruder, etc., with varying roles. The basic fighter has four 20-mm. cannon and four 0.303 machine guns, all mounted in the fuselage nose, giving highly concentrated fire. The basic bomber carries 2,000 lbs. of bombs with a fuel range that brings practically the whole of Germany within its reach. It has been referred to as the most versatile first-line aircraft in the world today.

The design was not started until after the war began, so that it is claimed to represent a world record in time taken from drawing board to operations against the enemy—22 months. It is the first de Havilland war aircraft to be put into production since the DH.9 and DH.10 single-engined and twin-engined bombers of 1918, production of which at the main factory alone then exceeded 250 per month.

The design team of the parent de Havilland Company in England, which was responsible for the Mosquito, is headed by Capt. Geoffrey de Havilland and includes C. C. Walker, Chief Engineer of the de Havilland Company and a founder-director; R. E. Bishop, Chief Designer; and R. M. Clarkson, Assistant Chief Engineer and Head of the Aerodynamics Department. These men conceived the design formula of the Mosquito in the first few weeks of the present war.

The idea was to create around two Rolls-Royce Merlin engines, a small, clean bombing aircraft with useful range and bomb load, which would be faster than contemporary fighters. The fighter version was a natural development from the bomber version. The de Havilland Company was allowed by the Air Ministry and Ministry of Aircraft Production to proceed with the design work as a private venture, and, although the company was given several changes of instruction as to how the first few aircraft ordered were to be finished (which meant building and flying both fighter and bomber prototypes), the Mosquito was actually in operation duty against the enemy within 22 months from the start of design work.

Wood construction was chosen for three main reasons: (a) to get more quickly through design and prototype stages and into production, in view of the grave urgency of the times; (b) to tap new material supplies; and (c) to employ a fresh labor group.

There were other advantages of buoyancy, ease of repair, etc., and wooden construction lends itself remarkably to dispersed production. Furniture and other woodworking factories, large and small, have converted to Mosquito work.

The Mosquito may be considered as a United Nations effort. The Rolls-Royce Merlin engines are now in full production by the Packard Motor Car Company. The de Havilland full-feathering constant-speed propellers are of the type created and produced by the Hamilton Standard Propellers Division of the United Aircraft Corporation. The de Havilland Company in Australia also has large works producing these propellers for the Pacific war fronts.

All the principal features of the Mosquito construction have recently been revealed by the makers who state that the stressed-skin wing and fueslage are similar in structure to the Albatross aircraft of 1937, and their weathering durability was therefore well-known from operating experience in European, Arctic, and tropical climates. The wing structure was developed from the Comet racer of 1934, and the form of the Mosquito also traditionally resembles that of the Albatross and the Comet, of which it is therefore the direct descendant.

Timber of other than first grade can be used. Wood has interesting features. To create a wooden air frame with the same strength factors as a metal air frame, spars and other members obviously have to be bulkier, with the result that bullet holes represent a smaller percentage of the mass of the member they pierce. This has proved a good thing in practical warfare. Repairs are easily effected by carpenters of ordinary skill. The natural buoyancy of wood is another comfort to pilots; Mosquitos have floated for many hours.

Besides its wooden construction, the Mosquito embodies other unique features, notably for simplifying manufacture. Dividing the fuselage shell longitudinally simplifies installation work. A compression-rubber type of undercarriage leg, which can be made by any ordinary subcontractor, eliminating high-precision tubing, pistons, valves, etc., has been successfully employed; it is in fact a development of

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the Moth undercarriage, never previously used on so large an aircraft. A simple hydraulic chassis leg made from plain tube and eliminating specialized valve gear, etc., was developed from undercarriage retraction. The use of machined parts, forgings, dural extrusions, and light alloys generally was minimized; indeed forgings were practically eliminated by the use of high-strength castings. The stub-wing location of the radiators is good aerodynamically and permits almost any degree of cabin heating without extra weight. The de Havilland Aircraft Company, Ltd.

High Heat-Resistant Plastic

A new formulation of Lucite molding powder to make plastic articles that will withstand much higher temperatures than those made from commercial thermoplastic powder was announced recently. This special formulation, called high heat-resistant Lucite methyl methacrylate resin molding powder, is a war development of du Pont's plastics research laboratories. It will be available for numerous peacetime uses.

Many articles molded from this new powder will not soften appreciably or distort when exposed to a temperature of 212°F. This was stated to be 30° to 40°F. above the useful temperatures for similar articles made from other commercial thermoplastic molding powders.

Airplane flying-light lenses, dial and meter faces, medical and dental instruments, and airport and railroad signal light lenses are among the applications for which the plastic molding powder has been developed.

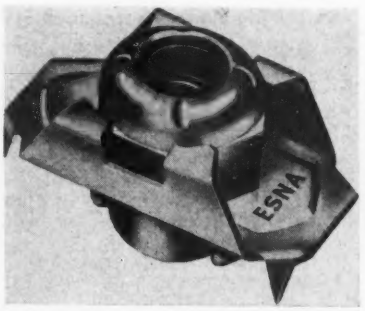
Lucite molding powders are prepared from the same basic materials as the cast sheets that now are formed into the noses, gun turrets, navigation "blisters," and other transparent enclosures on military planes.

The high heat-resistant formula has approximately the same mechanical, optical, electrical, and molding properties as the general-purpose Lucite molding powders now used for reflectors on military vehicles, Army compasses, Navy control equipment indicators, and other items of ordnance. Articles made from it are crystal-clear, or the powder may be dyed or pigmented to desired colors.

The new formula was developed for use in existing compression, injection, and extrusion equipment. The best technique for molding this powder requires injection temperatures 30° to 50°F. higher than are used for regular Lucite. However, it is advisable to employ the lowest temperature at which the die cavities will fill.

The new powder will be available in granular form for compression molding and has all the temperature characteristics of the injection or extrusion powder. Most satisfactory compression results are obtained by using 20° to 50°F. higher mold temperatures than are required for general-purpose Lucite.

Good extrusion results are obtained by using a short screw and a low screw speed, preferably 5 r.p.m. or less. Stock must be thoroughly dried. A moisture content not exceeding 0.02 per cent is necessary for best extrusion results. Machine cylinder temperatures are from 30° to 50°F. higher than for general-purpose Lucite. E. I. du Pont de Nemours and Company, Inc.



Elastic Stop Nut Corporation's new self-locking stop nut for use in plywood construction.

New Stop Nut for Plywood

A new self-locking fastening device for use on plywood construction will be used in the manufacture of plywood airplanes. Tested and approved by the Army Air Corps, this stop nut is claimed to fill the need for a fastening that can be installed from one side of the work, to provide a washer surface, to leave the outside of the plywood surface smooth, not to twist in the hole, and to require no special tool to affix. It is strong against axial movement, replaceable in event of damage, and independent of the thickness of the wood.

The device is a combination nut and basket that retains the self-locking principles of the maker's other products, so that the bolt is held secure under severe vibration. A regular elastic stop nut, with the red cellulose locking collar, is used interlocked with a basket that locks into the plywood and holds the nut securely.

Four prongs at the corner of the basket sink into the surface of the plywood, and two feet inserted in the hole are forced into the wood as the nut descends, firmly anchoring the basket. Spring fingers at the top of the basket clasp the nut after it is seated and hold it firm against axial play. The nut can be installed in three easy ways—driven in with a hammer, forced in with a press, or drawn in with a bolt. No special tools are needed.

After it has been applied to the surface, the nut is held against turning by four prongs on the corner of the washer plate and also by the feet that have been pressed into the sides of the hole. This construction makes the nut independent of the thickness of the material; it can be used on plywood from $\frac{1}{8}$-in. up.

The nut is replaceable without moving the basket, and $\frac{9}{32}$ and $\frac{10}{32}$ nuts are interchangeable in the same basket. A small hole of $\frac{9}{32}$-in. diameter is all that is needed in the wood. The basket part of the device is extremely light, weighing only 4 oz. per 100. Elastic Stop Nut Corporation of America, Union, N.J.

"Sealed" Relay

A new-design, hermetically sealed relay has a sealed chamber that is designed to reduce fire and explosion hazards of exposed contacts and to help prevent gas-leak dangers in warplanes. The relay weighs only 4.6 oz., yet it is capable of excess loads. An overtravel spring is provided to give positive action and instant break release. Another feature is the reversible contacts affording new surfaces without disturbing adjustments. Electrical Products Corporation, Los Angeles, Calif.

Airplane Tire Bead-Loosening Tool

A new tool for loosening airplane tire beads from the rims is announced. This device eliminates the necessity for using such severe methods as rolling caterpillar tractors and half-tracks across the tires to break them from the rims. Compact and conveniently packed, the tool is suited to a front-line emergency field as well as to a regular airport. Because it makes possible the removal of tires without damaging them, the new bead-loosening tool is expected to mean an important saving in rubber and at the same time to speed up airplane tire service work. The bead loosener is provided in a kit 38 by 6 by $6\frac{1}{2}$ in. weighing 48 lbs. The kit contains enough equipment to carry through the work of demounting a tire and mounting it again.

A metal bar, hooked at one end with an adjustable lever attached near the straight end of the bar, and two detachable hooks make up the bead-loosening tool. With the tire laid flat and deflated, one of the hooks is attached to the straight end of the bar, and the two prongs then are fitted into place where the tire and rim join. Pressure is next applied to the lever to force the detachable hook between the tire bead and the rim.

The hook is then detached but left in place between the rubber and the metal, and the operation is repeated with the other hook about 8 in. away from the first one. Next, a specially built tire iron included in the kit is placed between the bead and the rim flange alongside the first hook. The lever then is released, and the hook is removed so that a groove in it can be made to straddle the tire tool. Another pull on the lever forces the point of the hook between the rim flange and the tire iron. The tire iron is pushed upward to force the bead down, and the process is repeated at several points around the tire. Next, the main section of the bead loosening tool is removed, with the two detachable hooks left in position between the tire bead and the rim.

The new bead-loosening tool developed by the Firestone Tire & Rubber Company loosens a huge airplane tire from its rim.

Two tire irons are then used starting in the space between the two hooks. Inserted between the rubber and metal, one iron is pushed upward and the other downward. This operation is carried on all around the tire until the bead is loosened. The tire then can be turned over and the bead on the other side eased loose in the same way. Firestone Tire & Rubber Company.

Rubber Substitute

A material to replace scarce rubber in many aeronautical uses is composed of bound animal hair mixed with a small percentage of reclaimed rubber. It is stated that this material is lower in cost than rubber. Its aeronautical applications include parachute back fillers, parachute seats, pilot seats, bombardier pads, and similar products. Firestone Tire & Rubber Company.

To Hold Different Size Pieces for Milling

A universal pressure equalizer for clamping multiple pieces of different thicknesses which cannot be held in a standard clamping device has been developed in General Electric's radio transmitter planning department.

It is constructed with movable parts that allow pressure to be shifted and equalized across the face of the clamp. Multiple pieces then can be held tightly even though there is a variance in their thickness due to machining tolerances. An ordinary vise could not hold a multiple of pieces tightly enough for machining purposes.

The shifting of pressure is accomplished by allowance for movement of the equalizer parts, which consist of half-round and triangular pieces. When there is a difference in thickness of the parts to be held, the half-round pieces shift their position and the triangular pieces shift into position behind them, holding the part securely.

The equalizer is primarily for milling and can be used with any standard or cam vise. It is adaptable for clamping either round or rectangular pieces as well as pieces with irregular surfaces such as castings. It can also be used as part of an assembly fixture. When used in a vise, it is fastened securely to the movable jaw. The stationary jaw is then made to suit the shape of the parts to be machined and is spaced to match the equalizer. General Electric Company.

Machining Supercharger Impellers

It is reported that fly cutters with cemented carbide inserts about 3 in. long have been found superior to conventional straddle-milling cutters in machining the blades of impellers for airplane superchargers at General Electric. The cemented carbide inserts last five times longer, without regrinding, than the multitooth milling cutters of high-speed steels previously used.

In the initial operation the impeller is held in a fixture and hand-indexed to machine each blade individually. A second milling machine with carbide-tipped fly-cutters spaced at opposite diameters of the cutter bar is used to remove the metal remaining in the triangular areas between the blades from the first cut. The shape of the pads of metal to be removed requires that the work be oscillated to give a wider sweep at the outer ends of the cut. To accomplish this, the impeller is mounted on an arbor oscillated by a universal shaft driving through a gear reducer. Sharp edges are then removed and the tool marks polished out. Then the upper edges of the blades are formed to correct curvature by a punch and mating die in a pneumatic press. Each blade is "curled" individually, the piece being hand indexed between press strokes.

The impeller is next transferred to a milling machine equipped with an angular head, and a hole is drilled and countersunk with a combination tool in the web at points midway between blades. To do this, the work is located on a vertical arbor on the bed of the machine and is indexed by hand prior to drilling each hole. The work is located after each indexing by a slide with a block of fiber at its inner end tapered to fit between the side faces of the blades. General Electric Company.

Milling Head on Boring Mill

By mounting a milling cutter on a vertical head of a boring mill, it has been found possible to eliminate setup and handling time, as well as to save time in moving a job to another work station in order to mill one or more flat surfaces. The method has also been used to advantage in milling flat, true surfaces in correct relation to a previously machined curved surface. One application has been in milling flat pads on aluminum castings while clamped in the boring mill. The pads are located inside the bore of the casting.

The method calls for a 3-hp., 600-r.p.m. gear motor mounted base-up on a "T" bracket adapted to fit the tool holder of the head of a 6-ft. boring mill. A 6-in. milling cutter is attached directly to the end of the shaft of the gear motor. After the milling head has been correctly positioned, a dowel pin is put through the head and into the shank of the tool holder.

To use the milling head, the operator first correctly locates the job in relation to the milling cutter. The amount of stock removed may be measured in terms of the scale on the rail of the mill. The cutter is then started and hand-fed into the work. "Rapid traverse" may be used to move the cutter over long distances between intermittent cuts and also to back the cutting head away from the work. A coolant is applied to the cutter while it is in use. General Electric Company.

Speed Clamps

The Quick Lockcet clamp is designed for light, fast work and possesses a trigger release. The seat of the clamp has a swinging, locking lever, a gib that is claimed to make it noncreeping and to assure a firm grip on any parallel, slanting, or rounded surface. The teeth of the release trigger are under spring tension to hold a firm ratchet grip on the screw, which is released instantly with trigger pressure by thumb or finger. Thus the screw may be slipped to any desired position with a single motion for immediate resetting or may be instantly reclamped to other work of the same thickness without any further screw adjustment.

The Quick Lockcet clamp has a free acting swivel with fiber face to prevent scarring and marring and may also be had with complete fiber jaws for work on aluminum and other softer metals. Both types are made in three sizes and all have copper plated screws and swivels to prevent damage from welding spatter. Grand Specialties Company, Chicago, Ill.

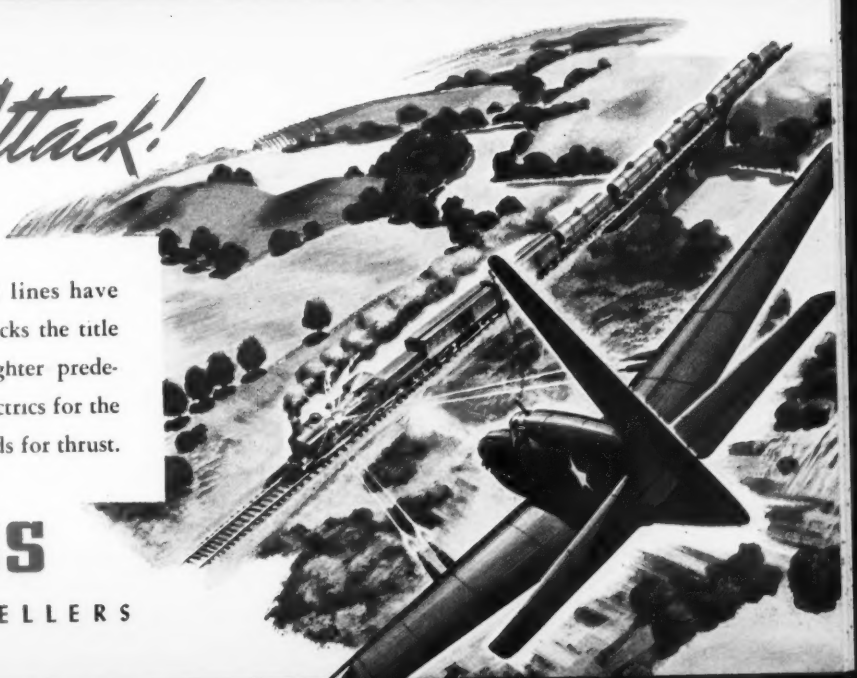
Mechanical Cement Spreader

Special mechanical equipment for spreading cement in soil-cement surfacing has been developed by the Civil Aeronautics Administration and the Halliburton Oil Well Cementing Company. The Civil Aeronautics Administration's contract with the Halliburton company called for a spreader capable of accurately and rapidly applying either bulk or sack cement to the soil in any required proportion. For possible use in remote battlefields, the C.A.A. specified that the equipment be of such size and weight that it could be transported by air. No individual piece of the spreader or the feeding accessories weighs more than 750 lbs., and all parts can be put into the standard door of a military transport plane.

The new spreader is built of standard materials and designed to be towed by truck or tractor. It produces an even distribution over an area 6 ft. wide in any quantity desired, between 0.3 and 0.75 cu.ft. per square yard of surface. Eight 6-in. conveyer screws feed cement from a common hopper to the outlet spouts, which in turn distribute it to

Mustang Attack!

Devastating raids on enemy rail lines have earned North American A-36 Attacks the title of "Train Busters." Like their fighter predecessors, they depend on Curtiss Electrics for the instant response to variable demands for thrust.



CURTISS

ELECTRIC PROPELLERS

Information supplied by an Industrial Publication

Tool breakage—even in what was once considered "normal amounts" is something to be avoided by any means today. Replacement supplies are hard to get, and the possibility of tool shortages is too serious to permit temporizing.

In many cases breakage can probably be considerably reduced by educating operators in the proper use of cutting tools. In some instances, redesign of the tool may be the remedy.

Redesign was the solution in the case of countersink drill bits used in an aircraft factory. Bits having cylindrical pilots often broke when the center line of the bit was at an angle with that of the drilled hole. Run out in the spindle could easily cause such deflection.

The remedy suggested by an employee consisted of equipping bits with a spherical, or ball shaped, pilot. Such a pilot has the effect of making bits self aligning. Deflection through a relatively wide angle cannot concentrate enough stress at the neck of the pilot to cause breakage, because the end of the bit is not rigidly held.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Mo-lyb-den-um Company
500 Fifth Avenue • New York City

the ground. The quantity of cement is regulated by a simple dial setting that controls the gear ratio between the driving mechanism and the conveyer screws by means of an infinitely variable speed transmission. Power is obtained from the dual wheels of the spreader, using an automobile differential so that the rate of the turning of the screws is directly proportional to the forward speed of the spreader.

Two means of feeding the cement are provided. One consists of a hamper to rest on the bed of the truck towing the spreader. The operator cuts the bag of cement on a special knife and feeds the cement into the hamper. The other is a convoy unit that supplies bulk cement and is placed on a flat bed truck that tows the spreader. It delivers cement to the hamper by means of spouts and incorporates a power unit to keep the feed constant. This unit delivers not less than 25 sacks of cement per minute.

Three tests were made of the equipment by the C.A.A. Technical Development Division: laboratory calibration of the spreader; road test of the spreader and convoy unit; and field tests under actual operating conditions. A total of 300,800 lbs. of cement were used, spread over a total of 6,118 square yards, at an average of 48.78 lbs. per square yard. The average delivery rate was 29.15 sacks a minute and the average percentage of cement applied to the roadbed was 11.53 per cent. Results of the tests will be made available in a technical report by the C.A.A. Halliburton Oil Well Cementing Company, Duncan, Okla.

Metal Saw for Wet Cutting

A new model saw, designed especially for wet cutting, has been developed for Johnson saw users engaged in work requiring ultra-high-speed cutting.

The coolant pump is a nonclogging piston type, driven by noiseless cam and mounted in the frame without impairing the overall streamlining of the machine. No additional power is required; power is taken from the present drive gear, eliminating necessity for a separate motor with its special wiring and extra switches. The speed of the pump is automatically regulated by the speed of the machine; flow of coolant is in direct relation to blade speed. The pump automatically stops and starts with the machine. A steady flow of coolant is provided through use of a ram which smooths pump impulses. If dry cutting is desired, the pump can be readily disconnected. Johnson Manufacturing Corporation, Albion, Mich.

Welders' Helmet Ventilator

A ventilator for welders' helmets has been invented for the purpose of eliminating the danger of poisoning by galvanizing fumes and to banish all smoke from within the helmet.

The device is attached to the headband of the helmet and introduces an even flow of fresh air into the helmet. There is no draft on the face or head, and the maker states that after more than 10 months' experience, there has been no reported instance of pneumonia or head cold.

Manufactured and marketed under the name of Cleanaire Ventilator for welders' helmets, the attachment weighs only $3^1/_2$ oz. and takes but a moment to attach to the headband. Three to 5 lbs. of air from any respirator line is ample for satisfactory operation. W. H. Kitchen Company, Seattle, Wash.

Diamond-Dressing Tool

"Kodi," a new diamond dressing tool that fits most standard grinding machines, is intended to eliminate the necessity for a special dresser for each machine. It is supplied initially with a special shank or Ko-Adaptor, fitted with a recessed head set screw that locks the standard Kodi nib in position. Once installed, the adapter remains on the machine. Only the nib is removed for resetting or replacement. Since one nib fits all adapters, the replacement supply need never be large.

Graduations, placed in a developed sequence to guide the operator, are an additional feature of the tool. Longer wheel life and greater grinding efficiency are claimed to result from the fact that diamonds turned frequently insure constant sharp points. Koebel Diamond Tool Company, Detroit, Mich.

Learmatic Navigator

The Learmatic navigator is stated by the makers to combine the functions of the automatic radio direction finder and the directional gyro. It integrates the indications of these two basic instruments and automatically gives the pilot a continuous graphic solution to many navigational problems.

With this instrument, the pilot sees at a glance not only his present position and heading but also how his position and heading are changing with respect to his ground reference and his desired track. It is claimed to simplify straight-line navigation toward or away from a radio transmitter station under varying drift conditions and without visual reference outside the navigation to any destination not provided with a radio beam transmitting station. Lear Avia, Inc., Piqua, O.

New Test Drive for Aircraft Tachometers

A compact, new, self-contained, variable-speed test drive for testing aircraft tachometers is of motorized, fully enclosed, splash-lubricated, all-metal construction, with $^1/_2$-hp. electric motor integrally mounted on one end. It utilizes the basic Link-Belt V.R.D. speed variator, has an overall speed ratio of 10 to 1, and is furnished with four vertical drive shafts for mounting of tachometers or with special swivel head to permit testing in either horizontal or vertical position, as may be desired.

The four drives can be supplied all alike or in any desired combination. An interchangeable type of drive can also be furnished. Output shaft speeds of 200 to 2,000, 250 to 2,500, 300 to 3,000 r.p.m., or other speeds with an overall speed ratio of 10 to 1 can be furnished. Another feature of the unit permits direction of rotation to be selected for each shaft. Thus, for example, it is possible to operate two tachometers in one direction and two in the opposite direction, and test all four simultaneously.

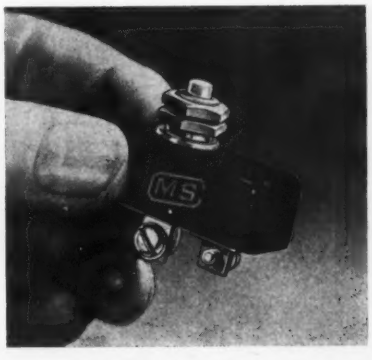
It is stated that infinite speed control can be obtained at will by the simple turning of a hand wheel, requiring 5.84 total turns for the full 10 to 1 speed range. Hand-wheel-operated vernier control, with a ratio of 7.5 to 1 or 30 to 1, can be furnished for more precise speed variation. Link-Belt Company, Philadelphia, Pa.

Peanut Micro Switch

The new Peanut Micro Switch is no bigger than the end of a man's index finger but is claimed to be more rugged, lighter, and more resistant to vibration than the larger models. It is expected to fill a new place in electrical circuit control.

The Peanut is available both with and without an enclosing case. When used without the case, the actuating movement can be applied anywhere over a large portion of the upper spring. With the Bakelite case a convenient stem mounting is provided. The construction provides inherent overtravel beyond the point of operation great enough for most uses.

Other features include: (1) contact gaps up to 0.083 in. which can be varied in the manufacture (this wide gap is especially valuable on d.c. loads); (2) pure (99.95 per cent) silver contacts, formed with a knurled surface to provide high unit contact pressure for low-voltage applications. These surfaces also reduce danger of dirt in the contacts when an enclosing case is not used. The Peanut Micro Switch is especially suitable for uses where extremely low operating force and super-fast action are not of primary importance. Micro Switch Corporation, Freeport, Ill.



Peanut Micro Switch.

Curved Panels Made Without Costly Dies

An advanced technique in plastic molding is claimed to make possible fabrication of parts and panels in cylindric shapes or simple and compound

THE SKY IS NO LIMIT

There is only one way for any builder of an airplane engine to approach his job, and that is to make each part as fine as he is able to make it. ★ But in achieving this goal, Allison started with two special advantages. ★ One was the opportunity of drawing upon all General Motors' "know-how" in the perfection of manufacturing techniques. ★ The other was a privilege which had been ours for many years—the privilege of concentrating on assignments calling for high skill and precision in working with metals. ★ Perhaps we are aiming high, but with two such advantages it is natural our aspiration should be to seek to build ever finer aircraft engines.

LIQUID-COOLED AIRCRAFT ENGINES

POWERED BY ALLISON
P-38 — Lightning
P-39 — Airacobra
P-40 — Warhawk
P-51 — Mustang

Allison

DIVISION OF GM GENERAL MOTORS

curves at low initial costs. The method bears special application to the production of parts in small quantities where ordinarily initial costs of tools, dies, or steel molds would be excessive.

A typical product of the new method is an airplane panel. The panel is accurately machined to accommodate levers and knobs and conforms rigidly to multiple curves specified by the designers. It measures 27 in. long by 7¾ in. wide and shows indications in depressed white enameled letters that are conspicuous and legible because of their color contrast with the black panels. Panels of this type, heretofore made of aluminum, required a steel die to form the curves. By the new technique, the thermoplastic panels are first molded flat and, while suspended in a semicured state, yield to curves of an inexpensively built forming device.

The plastic panels are claimed to be considerably lighter than aluminum and much lighter than other metals. The new method solves cost factors in limited production for various instrument, equipment, and industrial applications. The Theodore Moss Company, Brooklyn, N.Y.

Some Problems in Which the Army Is Interested

The National Inventors Council has secured the consent of the Army to the release of a list of some of the problems in which the Army is interested. A practical and effective solution of any of them will be a real contribution to the war effort. Actual war experience has shown the need of various devices or methods not practically available and has also shown the need or the desirability of substitutes or alternatives for devices and methods that are already in our possession.

While information of the needs of the Army has only been given to agencies officially authorized to receive and use it, such a list has not heretofore been released, since it might give information of what we possess or do not possess. The present list is not of this character and is being released to appropriate professional societies and research organizations in order that it may be passed along to their membership. Additional lists may be released in the future.

Suggestions on any of these problems should be submitted to the National Inventors Council, Room 1313, Commerce Building, Washington, D.C., and should comprise a clear description of the proposal with such sketches or drawings as may be necessary.

The following is a list of the subjects on which suggestions are desired:

(1) A method of removing the tetraethyl lead from leaded gasoline to make it usable in stoves, lanterns, and small engines.

(2) An inexpensive metal suitable for Quartermaster tableware; one having requisite strength, freedom from corrosion by food acids or alkalis, and durability and attractiveness.

Aircraft panel of molded thermoplastic made without costly dies.

(3) Suitable substitute for rubber for insulating wire; should be flexible and durable.

(4) Detectors of enemy personnel who may be approaching (unseen) on jungle trails or fences or similar barriers.

(5) Sonic or supersonic means or methods of signaling in the field.

(6) Improved means or methods of signaling the identification of ground troops to friendly airplanes and vice versa.

(7) Improved traction devices for wheeled vehicles of all types. NOTE: Present chains and other devices are cumbersome, inconvenient to apply and remove and lack sufficient traction.

(8) Tracks for tractors and other motorized equipment that will operate efficiently in snow and extreme cold.

(9) Better air cleaners for use on tank engines and the like; more effective than present cleaners and requiring less maintenance.

(10) Methods of quick-action waterproofing for enabling vehicles to ford water several feet deep, without stalling engines.

(11) Storage battery not adversely affected by extremely low temperatures.

(12) The detector and method of locating nonmetallic land mines.

(13) Equipment or methods for removing land mines rapidly from mine fields without injury to equipment or personnel.

(14) Methods of rustproofing ferrous metals, which are more durable than present methods, such as bonderizing, etc.

(15) Absorbents for carbon monoxide or catalysts or other means for oxidation of this gas to render it noninjurious to personnel.

(16) Means of defeating darkness to permit vision at night without aid of visible reflected light. NOTE: Probably involves an apparatus to translate infrared rays to visible light.

(17) Means of long-distance communication outside the present scope of radio and not restricted by line-of-sight projection.

(18) Searchlights that may afford ready means for spreading the beam from narrow high intensity to 15° of greatest intensity practicable.

(19) A simple nontoxic process for darkening aluminum and other metals to make them nonreflectant to light.

(20) Methods of sabotage by friendly inhabitants within occupied areas.

Safety Equipment

A 5-page special service report on protection of workers against preventable accidents emphasizes the necessity for providing adequate facilities for maintaining personal safety equipment and discusses the equipment and materials required for effectively carrying out such a program. The four essential steps in handling maintenance of respiratory and other equipment are described, together with recommendations and detailed instructions.

Since there is considerable variance in the design and construction of respirators and goggles, special care must be taken when cleaning sensitive metal and rubber parts. It is shown, for example, that strong alkalis should be avoided for cleaning aluminum or aluminum-alloy parts of safety equipment. Rubber parts, because of their particular sensitivity to strong solvents, grease, oil, etc., should be cleaned with mild detergents.

Methods for care and maintenance of goggles, helmets, and shields of both plastic and metallic construction; hose masks; and rubber gloves are also discussed. The report cautions against the use of strong alkalis or solvents when cleaning fiber helmets with special varnish or lacquer finishes for the reason that such materials may remove these protective coatings.

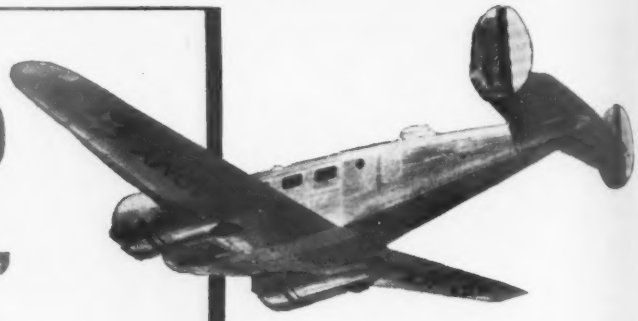
Before chemical treatment is applied to the glass shields in welding hoods to lessen breakage and prevent slag adherence, glass surfaces should be free of oil, grease, paint, etc. A fast effective method is outlined for putting glass in this condition.

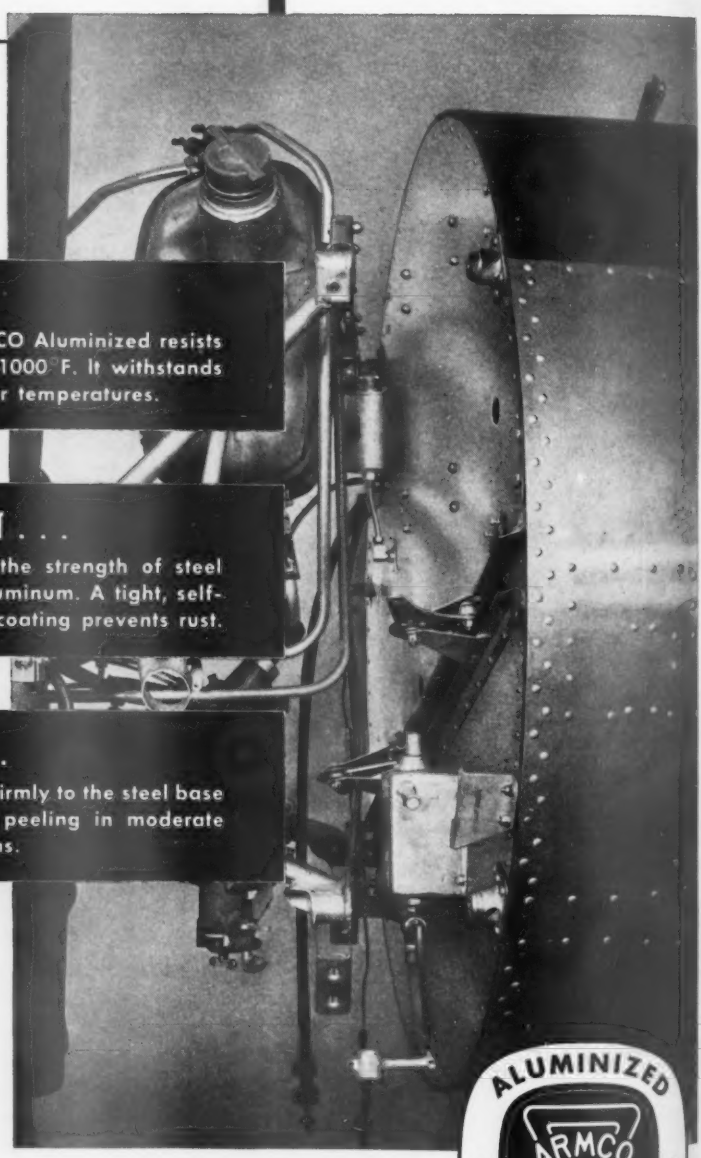
The subject of germicidal treatment of respirators, goggles, etc., by several different methods is also discussed. Many hints and suggestions for handling the maintenance of safety devices in a fast, orderly manner are also included, all based on plant experience. Oakite Products, Inc., New York, N.Y.

ALUMINIZED

"MAKES GOOD"

IN FIREWALLS





More and more of Uncle Sam's warplanes are now being equipped with firewalls made of ARMCO Aluminized Steel. This new ARMCO sheet metal is saving many tons of critical alloys for other essential uses. Check these "reasons why":

RESISTS HEAT . . .
The aluminum coating on ARMCO Aluminized resists heat discoloration up to about 1000° F. It withstands severe oxidation at even higher temperatures.

FIGHTS CORROSION . . .
ARMCO Aluminized combines the strength of steel with the surface qualities of aluminum. A tight, self-healing film on the aluminum coating prevents rust.

FORMS READILY . . .
The aluminum coating adheres firmly to the steel base metal. There is no flaking or peeling in moderate drawing and forming operations.

Could you use ARMCO Aluminized Steel in the firewalls of *your* warplanes? Approved by the Air Corps for this task, it is now undergoing tests for other parts. ARMCO Aluminized is supplied with a plain or copper-steel base, in sheets or coils. Gages are 16 to 28. After the war it will be supplied with a finish that can be buffed. For more data write to The American Rolling Mill Company, 2131 Curtis St., Middletown, O.

ALUMINIZED ★ ARMCO ★ STEEL

THE AMERICAN ROLLING MILL COMPANY

Ohmite Circular Slide-Wire Rheostat

Ohmite rheostat potentiometer, designed especially for low-resistance, low-wattage applications, has found several applications in the instrument field. The unit consists of a length of resistance wire stretched tightly around the outside of a cylindrical core which is bonded to a ceramic base. The wire is firmly anchored to two terminals. Contact to the wire is made by a phosphor-bronze spring arm that is connected to a third terminal. The provision of three terminals allows the unit to be used as a potentiometer or voltage divider.

The maximum resistance that can be supplied on this unit is approximately 1 ohm, while the minimum total resistance can be made approximately 0.1 ohm. Since the contact arm travels along the wire from end to end, the resistance variation is stepless. Shafts for knob control or for screw-driver control can be supplied. Ohmite Manufacturing Company, Chicago, Ill.

Improved Stand for Airplane Engines

An improved type of preinstallation stand for airplane engines, possessing both simplicity and utility, has been developed by engineers in the maintenance department of Pan American Airways. Similar to a cradle, the new stand eliminates the uprights from which the engine was suspended in the old, box-like stand, permitting greater accessibility during the mounting of the nacelle. A pinion gear at the front permits the engine to be raised or lowered to convenient levels, while a foot lock keeps the stand stationary.

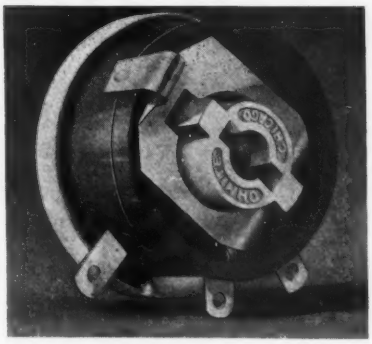
One of the chief advantages gained from the new stand is the ease with which mechanics can reach from the floor all sections of an engine under repair. In addition, it eliminates the interference caused by the supporting base channels in the old-type stands. Pan American Airways System.

Transformers Protected from Dust and Moisture

A new moistureproof and dustproof transformer is intended to meet all Navy and other specifications for hermetic sealing. These transformers use glass or porcelain insulators with metal bands. The insulators are soldered into the transformer case, which is of cold-drawn copper-plated steel, and thus become an integral part of the case. As in all Peerless transformers, the "Vac-sealing" impregnation process is used to insure absolute impregnation without solvents or other deleterious material present inside the coil. This is accomplished through the use of a special type of impregnant that cures completely under heat. Peerless Electrical Products, Los Angeles, Calif.

Multiple Thread Milling Cutters

Multiple thread milling cutters in National, Whitworth, Acme, V, and special forms are offered either ground or unground for use on any type of thread milling machine.



Ohmite rheostat potentiometer.

The manufacturer's experience gained in the manufacture of Plan-O-Mill, a machine used in thread milling a wide variety of parts—from gun tubes to spark plugs—is credited for certain improvements in cutter design—notably resistance to breakage and larger number of parts per grind.

Plan-O-Mill thread milling cutters are available with straight or spiral flutes, with or without special tooth for removal of imperfect thread. A complete range of sizes is offered. Plan-O-Mill Corporation, Hazel Park, Mich.

Repair Cart Spot-Welds Aircraft in the Field

A self-contained cart for repair spot-welding of steel parts of an airplane in the field, has been produced and is in service. Equipped with an electronic timer and a wide selection of both air-operated and manual "tong"-type guns, the repair cart is reported to be capable of doing any kind of spot-welding job on stainless and other light gauge steels.

Refrigeration of transformers, cables, and guns eliminates the need for external water connections, the condenser in the "Frostrode" refrigerating unit being air-cooled. The refrigerant in turn circulates a low temperature coolant through transformer, cables, and guns. Thus the only connection necessary to the repair cart is a power lead. Since the cart is provided with long cables, the connection can be made in a hangar or elsewhere and the cart rolled right out onto the landing field if necessary.

The cables are of the Progressive (P-H) concentric kickless type. Guns are so designed that a large variety of differently shaped electrodes may be mounted in them to reduce the number of guns to be carried on the cart and still assure the ability to weld in almost any position. Progressive Welder Company, Detroit, Mich.

Sperry Automatic Gun Sight

The Sperry Automatic Computing Sight is credited with being a major contributor to the reversal of Flying Fortress defense tactics and has helped make the B-17 the deadliest heavyweight fighter of the war.

The sight, an integral part of the Sperry-designed upper local and lower ball turrets, makes the 0.50-caliber machine guns effective at ranges up to 1,000 yards. Compared to the accurate range of enemy pursuit airplanes, this gives United States gunners a decided advantage—an advantage that enables them to destroy Axis attackers before they can get close enough to deal telling blows.

Although the sight has been a closely guarded secret, it is not new. Previous to our entry into the war, United States armament experts realized that their job was to make obsolete the weapons of our enemies. Determined to give our fighting men the finest weapons, they argued, among other things, for more adequate protection for our bombers.

In the early stages of the war, bombers with 0.30-caliber machine guns tried to shoot it out at close ranges with more maneuverable, faster, enemy attackers. This resulted in heavy losses of expensive bombers and trained crews. Our military experts argued for heavier 0.50-caliber guns and got them. Late in 1939 they asked Sperry engineers to design a precision sight, which was delivered for tests in the record time of 6 months—in May of 1940.

Early tests proved the computing sight superior to previous types, and the engineers predicted even better results if the Sperry Automatic Sight were used in conjunction with power turrets. This resulted in the equipment of the modern Flying Fortress with Sperry-designed upper local and belly turrets powered by hydraulic motors, designed and manufactured by Vickers, Inc., Detroit, a Sperry Corporation subsidiary.

One of the big advantages of the sight is that it takes the element of guess out of aerial gunnery. The effectiveness of other sights lacking the automatic feature depends largely on the inherent skill of the gunner and requires long periods of training.

The computing sight makes the calculations for the gunner and does the job more quickly and accurately. It automatically figures the "fall" of the bullet caused by gravity, the ballistic deflection caused by wind, and the amount of "lead" required to hit a target. Shooting from a fast-moving platform at a faster-moving target makes the problem more involved. Even though the muzzle velocity of 0.50-caliber shells is 2,700 ft per sec., the correct computation of lead, fall, and deflection is the essential ingredient of successful aerial gunnery.

As far as the gunner is concerned, when using the automatic device, he seems to aim directly at the target. The sight, however, points the guns automatically and continuously at the spot where the target will be by the time the bullets arrive. The gunner makes no mental calculations. Trained to recognize the various types of enemy pursuit planes, he has only to adjust the sight control to correspond to the dimensions of the attacker. If, for instance, the attacker has a wing spread of 40 ft., the operator turns the knobs to "40" on the dial. He must get the two illuminated verticle lines on the target—a line

TAKE IT APART AND SEE WHY!

Cutaway view of Littelfuse Extractor Post No. 1212-B

Littelfuse Mountings excel in providing security and protection of fuses, *and in safe and quick features for inspection, removal and replacement.* Detailed examination shows exclusive characteristics.

1. **Knob and body molded of black bakelite, impervious to temperature changes – thoroughly insulated preventing corrosion and shorts.**
2. ***Positive Fuse Grip* permits full visual shockproof inspection.**
3. ***Anti-vibration Terminals.* Side and end terminals integral with metal body parts, prevent vibration.**
4. ***Spring-activated* Cup insures positive and continuous electrical contact.**
5. ***Knob pulls and holds fuse.* Specially designed grip prevents fuse from dropping out.**
6. **Fuse can be taken from knob only by hand.**

Littelfuse

EXTRACTOR POSTS

Description	Cat. No.	Length Overall	Length from frt. of panel	Mounting Hole	Max. Current Amps.	How Operated	Use with fuses (applications)
Aircraft Fuse Mounting Extractor Posts for 4 AG Fuses (9/32" dia. x 1¼" long)	1212	2⅝"	2¼"	⅝"	40	Screw Driver (Undw's. Spec.)	Aircraft radio circuits, protecting vacuum tubes; transformers, motor generators, lighting, small motor circuits and many other general aircraft circuits.
	1212-B	2¾"	2¼"	⅝"	40	Finger	
	1212-C (Installed from rear of panel.)	2¾"	2 5/32"	⅝"	40	Screw Driver (Undw's. Spec.)	
Instrument Fuse Mounting Extractor Posts for 8 AG Fuses (¼" dia. x 1" long)	1087	2⅜"	2⅛"	½"	15	Screw Driver (Undw's. Spec.)	Meters and delicate instruments, Radio "B" circuits, thermocouples, test equipment, small rectifier and power tubes and for general instrument protection.
	1087-A	2⅜"	2⅛"	½"	15	Finger	
Fuse Mounting Extractor Posts for 3 AG Fuses (¼" dia. x 1¼" long)	1075	2½"	2⅛"	½"	15	Screw Driver (Undw's. Spec.)	Radios, auto radios, amplifiers, fractional H.P. motors, magnets, control circuits, relays, rectifier, plate circuits, etc.
	1075-A	2½"	2⅛"	½"	15	Finger	

Littelfuse makes Fuses and Mountings for every instrument purpose, Fuse Clips, Signalette Signal Indicator, Universal Fuse Panels, Etc. Write or wire for details.

Fuse every instrument and electrical circuit for safety with Littelfuses

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at the outermost tip of each wing. This he does by controlling the movement of the turret and by operating a foot treadle that spreads the verticals to keep them on the wing tips as the pursuit plane comes closer, thus automatically and continuously setting the proper range in the computing sight.

Lead, fall, and deflection are automatically and continuously computed on the basis of rate of turret movement transmitted to the sight. With this information it instantaneously calculates the relative speed between target and bomber and multiples the finding by the time of flight of the projectile.

The Vickers hydraulic mechanism moves the turret, guns, sight, and gunner as a unit. It moves them slowly or fast as the operator dictates. It relieves the gunner of the physical task of fighting the gun's tendency to align itself with the windstream. Because of the rushing air, it is difficult for the operator to track a target smoothly and surely. The turret's power feature corrects these shortcomings.

With the turret, the gunner cannot riddle his own plane. He is secure in the knowledge that a burst will be automatically interrupted when any portion of the bomber is in the line of fire. In addition, the turret makes possible the mounting of more than one gun per sight.

When the Sperry designed turrets were approved by the Army, prime contracts were awarded to Emerson Electric Company, Briggs Manufacturing Company, and Steel Products Company on a license-free basis. A license-free prime contract for the manufacture of sights was given out to the National Cash Register Company. The Sperry Corporation.

Profiler Produces Odd-Shaped Parts

A simple, inexpensive, automatic profile miller is designed to handle irregularly contoured parts in a production job. Load and unload time is reduced, requiring no machine stoppage. Operator fatigue is claimed to be lowered by unique features in its automatic action which make constant vigilance unnecessary.

The head of the machine carries the cutter spindle, mounted on precision Timken bearings, within the quill. The quill has a silent chain drive and hardened, helical change gears, running in oil. It has a 6-in. precision, vertical adjustment. The head is adjustable to 0.001 in. in positioning for work. The spindle nose has standard No. 40 taper and a selective speed range of 127 to 3,435 r.p.m. Spindle and table are independently driven and controlled.

Work is carried on a 14-in., rotating table, hydraulically controlled by a cam and follower mechanism. A ground center hole in the table facilitates positioning of work-holding fixtures. Two program discs determine rapid indexing cycles and automatic table stop to meet the requirements of a wide range of work.

Other features are: complete automatic hydraulic control of feed and rapid traverse; spindle quill lock; spindle-drive clutch brake, and work table stop. A pressure and gravity lubrication system is built into the machine. All working parts are fully inclosed for safety and for protection from chips and dirt.

Although the machine is particularly adapted to the making of gun and aircraft parts of odd contour, its usefulness as a postwar tool can be continued without alteration. Earl A. Thompson Manufacturing Company, Ferndale, Mich.

Plastic-Bonded Plywood Trainers for Navy

Plaskon resin glue and plywood are being used in producing training planes for the Navy by the makers of what are claimed as the first plastic-bonded plywood trainer ever awarded a Civil Aeronautics Administration type certificate and producer certificate and the first all-plastic-bonded plywood trainer to be adopted by the Navy.

In the new Timm N2T-1, as in the PT-220-C, which is now widely used for primary and secondary instruction in Civilian Pilot Training Programs, strips of plywood are permanently bonded together with waterproof Plaskon urea-formaldehyde resin glue. This synthetic resin is highly resistant to moisture, oils, gasoline, fungi, and extremes of heat or cold.

In the method of construction used by Timm, half-sectors of the fuselage are built up of three layers of spruce plywood, each $1/24$ of an inch thick. Inside and outside plies are laid lengthwise and the center ply crosswise, with two additional plies around the cockpit section. Plaskon resin glue is distributed uniformly over each layer with a spray gun before the next layer is added.

The two halves of the fuselage are then notched for cockpits and wings and fitted to the glue-coated framework. Wings and tails of the plane are also built up of layers of plywood bonded together with Plaskon glue. Timm Aircraft Corporation.

Cleaning Aircraft Spark Plug Shells

A new method for cleaning aircraft spark-plug shells employs Turco Type X and Turco De-Scaler as the chemical compound. The new method is claimed to remove all oil, grease, lead, and carbon deposits and leave the spark plug shells chemically clean.

The procedure involves a 1-hour submersion of the spark plug shells in a boiling 8-oz.-per-gal. solution of Tuco Type X; a thorough water rinse; a $1/2$-hour soak in a 50 to 50 solution of Turco De-Scaler and water; a second water rinse; and then a neutralizing dip into the Turco Type X solution. Shells should then be dipped in oil to prevent rusting. Where reblueing is desired, this step precedes the oil dip. Turco Products, Inc., Los Angeles, Calif.

First Helicopter Airport

The first airport in the United States exclusively for helicopters will be operated at the new plant of the Sikorsky Aircraft Division of United Aircraft Corporation in several buildings of the former plant of the Crane Company on South Avenue in Bridgeport, Conn.

The Division, which is building helicopters for the U.S. Army, has moved from its previous location with the Chance Vought Aircraft Division in Stratford to the Crane Company plant, which was formerly used for the manufacture of plumbing supplies.

This marks the final separation of the Sikorsky and Chance Vought divisions, which operated for many years as the Vought-Sikorsky Division. They were reconstituted as separate divisions in January of this year to permit Sikorsky Aircraft to concentrate on development and construction of helicopters, while Chance Vought Aircraft builds Corsair fighter planes for the Navy.

The Chance Vought Division will continue to occupy the factory and offices at Stratford and will expand into the space formerly used by the Sikorsky Division. United Aircraft Corporation.

Water Separator for Fuel Dispensers

A fuel separator used by many branches of the Army and Navy is claimed by the makers to deliver gasoline containing not more than $1/100$th of 1 per cent of undissolved water regardless of whether the water is in free form or emulsion, a proportion considered safe for aviation fuel.

These separators are manufactured in various capacities from 50 to 500 gal. per min. The 300-gal.-per-min. type is designed particularly for airport service and consists of a horizontal tank 24 by 60 in.; 4-in. flanged inlet and outlet connections are provided at the opposite ends of the separator. Interior construction consists of a contact chamber near the inlet and a setting chamber at the discharge end. A water accumulator is also provided at the bottom of the outlet end.

The efficiency of the separator is obtained by the use of a particular type of separating medium. Through the combination of contact with this medium and a low-velocity settling chamber, water globules are trapped, joined, and drained to the accumulator chamber.

By means of a float-operated drain valve, the water is automatically ejected from the water accumulator chamber. Should water accumulate faster than the automatic drain valve takes it away, an electronic safety switch will actuate and shut down the pumps, thus preventing the possibility of water being carried over into the distribution lines. When replacement of the separating medium is required, it is only necessary to pack in the correct amount of treated material, which is provided in cartons. Warner Lewis Company, Tulsa, Okla.

WHEN "METAL MEN" MEET PLYWOOD

Roddis Service saves time

Roddis provides the two essentials necessary to the successful application of plywood to aircraft production.

- A proved product—backed by 27 years of aircraft plywood experience and development—of the highest standard known to the industry — immune to the elements—and exceeding the rigid requirements laid down by Army and Navy aeronautical engineers.
- Able and experienced men—located in strategically placed branches throughout the country — trained in the 53-year Roddis' tradition of quality and craftsmanship—fully qualified to consult on the application of plywood to aircraft production.

While aircraft plywood is a seasoned story to Roddis and many designers of this and other countries who have worked with us for 27 years, Roddis recognizes that the expanding use of plywood for plane production is a new development to many men whose lives have been devoted to metal. The knowledge and experience of qualified men at our branches is available to all. Feel free to consult with them.

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Generator Brush Life Increased for High-Altitude Flying

To offset the effects of thin air and low humidity at high altitudes, a new method of treating the carbon brushes for aircraft generators has been developed by the Westinghouse Research Laboratories. With this development, life of the brushes has been increased from an average of 2 hours to well over 100 hours for high-altitude flying at 30,000 ft. or more.

These new brushes are now being applied to bombers and fighting planes in the Westinghouse 200-amp., d.c., P-1 generators. These generators supply the 28½-volt power for the electrical requirements, such as devices to lower and retract the landing gears, operate radio and lighting, vary the propeller pitch, adjust the wing flaps, and open and close the bomb bay doors

At ordinary low-altitude flying the standard carbon brushes gave satisfactory operation, but above 30,000 ft. the thin air and lack of moisture caused the brushes to wear rapidly and in many cases to give out entirely during a single flight. After extensive laboratory tests in which brush characteristics were observed in a vacuum jar and in specially designed chambers simulating high-altitude conditions, the trouble was remedied by the development of a special grade of brush for high-altitude flying. With proper ventilation and under average load conditions, brush wear for high-altitude flying has been reduced to one-thousandths of an inch per hour. Westinghouse Electric & Manufacturing Company.

Industrial Electronic Organization

To promote the use of electronics in industry on a broad engineering and commercial basis, Westinghouse has established a group of electronic engineers who will guide and direct the industrial, central station, and transportation electronic applications. This central organization will supplement the Company's present electronic divisions with specialized activity such as control, radio, lamps, and power conversion.

This step in centralization has been taken by Westinghouse to accomplish three primary objectives: first, to expedite present wartime applications of electronic devices; second, to be able to utilize to the fullest extent the present developments for postwar applications; third, to make immediately available to all other industries the developments and improvements found practical in one industry. The various industry engineering sections will retain the responsibility for making specific applications within their industry. This new central organization will act as consultants and coordinate the efforts on new developments pertaining to the electronic methods of doing specific jobs.

In connection with the establishment of the new electronics organization, the company has prepared a 40-page booklet titled *The A B C's of Electronics at Work*, primarily for the benefit of military and industrial technicians, to help them in their work through a clear, visual explanation of the six basic ways in which electronic tubes function. It explains the principles in nontechnical language, illustrated by numerous schematic drawings of the tube construction and diagrams showing typical circuits for the various functions of the tubes. A separate list shows some of the uses of electronics in industry, including such aeronautical applications as dynamometer regulation, voltage regulation, and the control of seadrome night lights. Westinghouse Electric & Manufacturing Company.

Taylor sensitive drilling machine. This machine is capable of drilling holes as small as 0.002 in. (See page 162).

Testing Shear Strength of Spot Welds

A quick, simple method for shop testing strength and soundness of spot welds has been developed in a Westinghouse plant. Spot welding is usually tested by "pulling a button," but this only reveals whether or not the material is actually welded and does not give any indication of strength or soundness of weld.

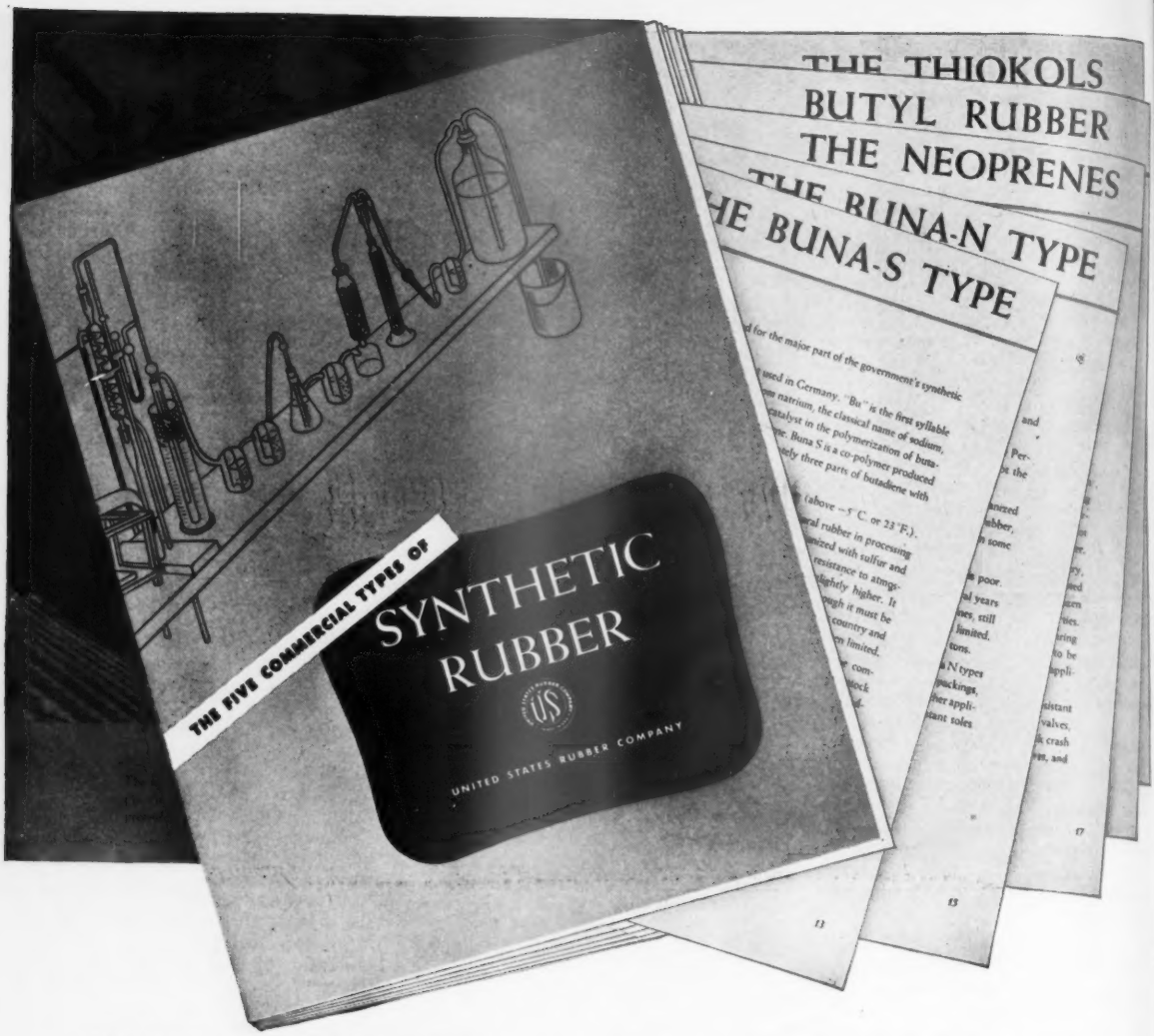
A small shear-testing machine is now used to make a thorough test. When an inspector desires to make such a test he takes two standard test pieces, cleans the surfaces, and makes the weld by overlapping the two pieces. The welded specimen is then clamped in the machine and a shear is applied. The force applied in pounds is shown by a gauge on the machine. A prepared chart shows the minimum strength required for the various thicknesses and types of material.

Advantages gained from the use of the shear-testing machine are: (a) aids in control of quality by giving a quantitative value of the strength of the weld; (b) serves as a quick check on setup of spot welder; (c) compact and simple to operate; and (d) permits tests to be made by operator or floor inspector instead of a laboratory technician. Westinghouse Electric & Manufacturing Company.

Changes of Address

To facilitate the prompt receipt of copies of the Journal and Review each month, members and subscribers are requested to give the editorial offices 30 day's notice of any change of address.

Notices should be sent directly to the Institute of the Aeronautical Sciences, 1505 RCA Bldg. West, 30 Rockefeller Plaza, New York 20, N. Y.



WHAT IS SYNTHETIC RUBBER? HOW IS IT MADE? WHERE IS IT USED? HOW DOES IT COMPARE WITH NATURAL RUBBER? *You'll find the answers in this new book*

As the supply of natural rubber diminishes, undoubtedly more and more mechanical goods will be made of synthetic rubber... hose, belts, packings, molded goods, tank linings, and other rubber products used by industry.

Having worked in the field of synthetic rubber for more than twenty years, we know what each of the five types will do; what chemicals such as sulfur, carbon-black, or ultra-accelerators must be added, and how to compound them. We work with all five types; use the type available that is best suited for the purpose.

You can get an over-all picture of the properties and characteristics of synthetic rubber in the new book recently published by United States Rubber Company. A request for "The Five Commercial Types of Synthetic Rubber" made on your company letterhead will be filled promptly. Address your letter to Dept. 29.

UNITED STATES RUBBER COMPANY

Listen to the Philharmonic Symphony program over the CBS network, Sunday afternoon 3:00 to 4:30 E. W. T. Carl Van Doren and a guest star present an interlude of historical significance.

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Institute News

Gifts to the Aeronautical Archives

Several notable additions for the model collection were received during the past month. The Consolidated Vultee Aircraft Corporation sent two large models of the PBY-1 and the XPB2Y-1. Models of the Lightning, Lodestar, and the Hudson were received from the Lockheed Aircraft Corporation. The Douglas Aircraft Company, Inc., gave models of the B-17F, C-47, and the A-26. A model of the Piper Cub was given by the Piper Aircraft Corporation.

Brig. Gen. Frank P. Lahm added a number of pamphlets and magazines to previous gifts and gave a fine collection of more than a dozen medals of which the Aeronautical Archives had not previously had examples. These included medals awarded to the donor and to his father, Frank S. Lahm, and a Frank Hawks medal of August 23, 1938.

George A. Page gave a collection of clippings and pamphlets relating to the work of the Wright Brothers, adding greatly to the collections given to the Aeronautical Archives by Hart O. Berg, Orville Wright, and General Lahm. Richard L. Singley sent some interesting Zeppelin items, and Nason H. Arnold gave a number of newspaper clippings and photographs.

Mrs. Bella C. Landauer sent gifts of sheet music to add to the large collection previously given. A. Leo Stevens added a number of clippings and early American periodicals to the collections given during the last few months.

Engine maintenance and operation manuals were received from the Jacobs Aircraft Engine Company, Menasco Manufacturing Company, Allison Division of General Motors Corporation, Lycoming Division of The Aviation Corporation, Kinner Motors, Inc., Ranger Aircraft Engines Division of the Fairchild Engine and Airplane Corporation, and Pratt & Whitney Division of United Aircraft Corporation.

A set of ten Admirals' Club glasses was received from American Airlines, a notable addition to the collection of glassware and china maintained in the Aeronautical Archives. Maurice Holland gave an interesting film, *Some Phases of Research Work Conducted by the Matériel Division, U.S. Army Corps, Wright Field, 1934.*

The collection of house organs continued to expand during the month, and the bound files of these form an important part of the source materials which are being collected. The British Air Commission in Washington sent an additional 16 *R.T.P. Translations*, keeping this valuable file up to date. The Shell Oil Company, Inc., gave 15 books, including the first edition of Monteith's *Simple Aerodynamics and the Airplane.*

JOURNAL OF THE AERONAUTICAL SCIENCES

To Be Issued Quarterly Commencing October

AS THE INSTITUTE is limited in the use of paper for its publications, it has been necessary to effect conservation measures on both the JOURNAL and the REVIEW.

The trim size of both magazines has already been reduced, as well as the weight of the cover stock used. This issue of the REVIEW has been printed on the lightest practical weight of paper stock meeting the mechanical requirements of publishing the magazine.

Additional conservation measures are also being put into effect and the July issue of the JOURNAL OF THE AERONAUTICAL SCIENCES was the last issue to be published as a monthly. It will commence publication as a quarterly in October.

The editorial contents of the JOURNAL will remain practically unchanged, as it is now planned to triple approximately the number of article pages in the quarterly issues as compared with the monthly issues. Members and subscribers will therefore receive the same service as formerly, although the change in frequency allows the Institute to save a large quantity of paper used for printing the covers of the magazine.

MALLORY BEARINGS *"Can Take It"*

RELIABILITY under brutal punishment is the first essential for aircraft engine bearings. Increasingly, they are called on to withstand greater stresses and fatigues. But Mallory Bearings can—and do—"take it", as the daily performance of thousands of fighter planes and bombers will attest.

To hold up under the terrific pressures imposed by combat conditions, Mallory Bearings must be finished to an accuracy that even a few months ago was considered a laboratory dream. Today, thanks to brilliant engineering progress in machine design, bonding and testing technique, Mallory Bearings and other parts silver-surfaced by the Mallosil Process are rolling off production lines, made with precision accuracy that meets the most exacting requirements.

Mallory Bearings are made by the Mallosil Process . . . the Mallory method of bonding rare metals (such as silver) to base metal backings. The process is applied effectively to both ferrous and non-ferrous metals . . . even when heat treated . . . without affecting their physical properties.

The Mallosil Process makes possible precision production, not only of bearings, bushings, pinion races, gear supports and other aircraft engine parts, but other applications in aircraft manufacture. Collector rings with Mallosil surfacing provide long, efficient service in the control mechanisms of bomber power turrets. Mallosil-processed copper coils, rivets, fuse clips, circuit breakers and relay parts give longer and better performance in electrical and communications devices.

Today, Mallory Bearings and other products improved by the Mallosil Process are given over to War effort. Tomorrow, those products will be available for peace-time development. And Mallory engineers will have a wealth of technique and experience to place at the disposal of every manufacturer who is planning design improvements for high-speed motive units. Consult us.

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Bennett H. Horchler

George R. Forman

Robert R. Dexter

New Officers of the Institute

Major Lester D. Gardner has been elected Chairman of the Council of the Institute, relinquishing the duties of Executive Vice-President which he has held for many years. He will continue to be President of the Aeronautical Archives. Bennett H. Horchler has been named Executive Vice-President, George R. Forman assumes the office of Assistant to the President, and Russell F. Rogers becomes Manager of the AERONAUTICAL ENGINEERING REVIEW.

Mr. Horchler has been associated with the Institute as Manager of the AERONAUTICAL ENGINEERING REVIEW and in other capacities since 1940. His career in the aeronautical industry commenced in 1918 when he joined the staff of the Manufacturers Aircraft Association, where he assisted those in charge of the promotion of the "First Annual Aircraft Exposition." Upon taking night-school courses in elementary mathematics, airplane drafting, and elementary aircraft designing at Columbia University and the College of the City of New York, he was employed by Chance Vought early in 1920 and assisted in the designing of various Vought aircraft. In 1925 he entered the field of business paper publishing by joining the staff of *Automobile Topics*, and in 1927 he transferred to *Aviation*, traveling extensively throughout the United States until, in 1929, he was made Western Manager with headquarters in Chicago.

In 1931 Mr. Horchler was appointed Manager of the Advertising Bureau of the Associated Business Papers and worked actively with numerous publishing associations, assisting in the work of the Affiliated National Conference of Business Paper Editors. He returned to active work in the publication field in 1937 with the Slocum Publishing Company, publishers of *Automotive News* and *Automotive Service*, continuing there until he became connected with the Institute.

Mr. Forman, Editor of the AERONAUTICAL ENGINEERING REVIEW, has been with the Institute since the time of its foundation and has assisted Major Gardner in executive duties connected with the operations of the Institute.

Joseph J. Maitan

Russell F. Rogers

Robert R. Dexter continues as Secretary of the Institute and Joseph J. Maitan as Controller.

New Corporate Member

Wolverine Tube Division of Calumet & Hecla Consolidated Copper Company has recently joined the Institute as a Corporate Member. In the past it has furnished seamless copper, brass, and aluminum tubing of many types to the aeronautical industry, including the fabrication of specially shaped aluminum tubing for use in intercoolers. In addition, millions of feet of thin-wall copper tubing for oil coolers have been drawn in Wolverine's modern tube mill.

A recently announced spun-end process shows considerable promise as a method of fabrication for the aeronautical industry. A typical spun-end job was the fabrication of a copper pitot tube housing.

Another important process produces "All-In-One" finned tubing, consisting of a helical fin integral with the wall of the tube. Fabricated in aluminum, this process has been used to manufacture components of space heaters for aircraft work.

The Manufacturing Division also produces tubular assemblies for aircraft production.

Sections and Branches

Buffalo Section

The first technical meeting of the Buffalo Section was held at Amherst Central High School on July 16, 1943, with an attendance of about 40.

The speaker was Dr. Harold V. Hawkins, Head Vibration Engineer of Bell Aircraft, whose subject was "Vibration Measuring Equipment." The speaker discussed the three essential parts of vibration measuring equipment, the pickups, amplifiers, and recorders, telling about the equipment in each category which is available commercially. The latter part of the talk was devoted to explanations of the physical principles involved in the de-

Photo by Office of War Information

PROTECTING THE "Nerve Center" OF A B-25 BOMBER

The young lady is attaching terminals to the panel of an electrical junction box, shortly to become the "nerve center" for a big B-25 bomber. To protect against static interference, incoming and outgoing wiring is encased in Flexible Low-Tension Shielded Conduit made by American Metal Hose.

Wherever planes fly, this battle-tested conduit is playing its part in supporting brilliant performance... enabling radio signals and directions to come in clear and undistorted. It is one of the important "tremendous trifles" that are helping American wartime aviation set so many outstanding records.

American Metal Hose makes a complete line of fittings and accessories for American Flexible Low-Tension Shielded Conduit. Both fittings and conduit conform to A-N, A-C and NAF specifications. We are also prepared to make complete assembly of conduit and fittings to meet individual specifications, thus conserving valuable time on the production line for aviation plants. Inquiries will receive prompt attention.

ANACONDA American Metal Hose

AMERICAN METAL HOSE BRANCH OF THE AMERICAN BRASS COMPANY • General Offices: Waterbury, Conn.
Subsidiary of Anaconda Copper Mining Company • *In Canada:* ANACONDA AMERICAN BRASS LTD., *New Toronto, Ontario*

sign of the pickup units. The lecture was followed by a brief discussion.

Detroit Section

At the Detroit Section dinner meeting on June 23, 1943, new officers were elected for the coming year as follows: Chairman, George H. Tweney; Vice-Chairman, Donald C. Hunt; Treasurer, John C. Squiers.

After the business session Glenn Doyle, Chief Salvage Engineer of the Murray Corporation, gave a talk on the subject of "Salvage Engineering in Manufacturing."

New York Section

A meeting of unusual interest was held by the New York Section on June 21, 1943, in the Auditorium of the Engineering Societies Building, 29 West 39th Street, New York. As an experiment, it was decided to call the meeting at 5:30 in the afternoon, to come between the hour of closing business and the dinner hour and thus offer the least possible interference with the working time of the members and guests. Over 1,100 persons attended the meeting.

Dr. Dryden, President of the Institute, extended a welcome to the Institute's friends and neighbors from Canada, Washington, the Middle West and other points, as well as the representatives of Corporate Members and other companies.

Mr. Elmer Sperry, of the Sperry Gyroscope Company and Treasurer of the Institute, presented to Major Gardner two books containing more than 260 letters and cablegrams from scientific and aeronautical leaders in this country and abroad, bearing congratulations to Major Gardner on his receiving the Degree of Doctor of Laws from the Polytechnic Institute of Brooklyn. Among the cablegrams were messages from The Royal Aeronautical Society, of which Major Gardner is an Honorary Fellow; from Lord Brabazon of Tara, the first man to fly in England; and from Griffith Brewer, whose career is the longest in active aviation—50 years as a balloonist and pilot.

Dr. R. Paul Harrington, Chairman of the New York Section, then took charge of the meeting. He introduced Dr. Igor I. Sikorsky, giving a brief sketch of his career. Dr. Sikorsky gave a review of his helicopter work, illustrated by motion pictures showing the performance, flexibility, and controllability of the helicopter.

At the conclusion of the Sikorsky lecture, Mr. Henry J. Kaiser, whose activities in shipbuilding and other industrial production for the war effort are now being expanded into the aircraft industry, was introduced. The Chairman extended a welcome to Mr. Kaiser and predicted that his achievements would be duplicated in his latest venture in the aeronautical field. In his response, Mr. Kaiser gave his views on the helicopter as an air vehicle of the future.

Seattle Section

The first meeting for the new year was held on June 23, 1943, at which Elliot V. Mock, of the Engineering Division of Boeing Aircraft Company, spoke on the subject "Postwar Air Transport Operation." He reviewed from an economic standpoint the various forms of transport, including steamship, railroad, bus, and air in the years prior to the war, and discussed the possible extent of air transport in the postwar era.

New officers for the current year are: H. R. Brown, Chairman; C. E. Rutledge, Vice-Chairman; A. C. Pearson, Recorder; M. L. Kellerman, Treasurer; C. I. Merrell, Program Committee; L. Slaughter, Jr., Membership Committee.

Casey Jones School of Aeronautics

William Boyce has been elected Chairman of the Student Branch to succeed H. Buck Edwardsen, and Asher Tishler was elected Vice-Chairman to take the place of William Boyce. These elections were held at a special meeting on June 23, 1943.

A regular meeting of the Branch was held on June 24, to which prospective members were invited. A brief talk was given by Harry J. Roffelsen, Senior Engineering Instructor, explaining the aims and functions of the Institute. Two Government films on *Aircraft Navigation* and *Airplane Construction* were shown.

Polytechnic Institute of Brooklyn

The annual banquet was held on Friday evening, June 25, 1943, at the Candlelight Restaurant in Brooklyn, at which the entire faculty of the Aeronautical Department were present, headed by Dr. R. P. Harrington. The guest speaker was Maurice H. Smith, Librarian of the Institute. In his talk, Mr. Smith gave a brief history of the Institute's Libraries, covering its resources, functions, and the usefulness of the Library's collection.

The new officers are as follows: Victor Zadikev, President; Joseph Kempner, Vice-President; John Pulos, Treasurer; Joseph Becker, Secretary.

University of Alabama

The first meeting of the summer quarter was held on June 30, at which prospective new members were told of the activities and advantages of the Institute. Two films were shown—*The Construction of a Light Plane* and *Jap Zero*.

University of Southern California

The last meeting of the school year was held on June 3. The program consisted of a lecture by R. E. Marquardt, faculty advisor, on the subject "Lateral Dynamic Stability."

News of I.A.S. Members

Morris C. Anderson has joined Zenith Optical Company as General Superintendent of the Instrument Division. He was formerly Assistant to Works Manager at W. & L. E. Gurley.

Warren G. Anderson, formerly Research Assistant at Massachusetts Institute of Technology, entered the service of Pan American Airways as an Engineer in the Transpacific Division.

Richard T. Baseler has been promoted to Project Engineer with the Pratt & Whitney Aircraft Corporation of Missouri.

Lawrence E. Beckley, now an Ensign in the U.S. Naval Reserve, has been assigned to the Bureau of Aeronautics, Materials Division, Structures Section, Engineering Branch.

Murray C. Beebe, Jr., has advanced from Experimental Engineer to Chief Development Engineer at the Hamilton Standard Propellers Division of United Aircraft Corporation.

John S. Chikes has entered the Army Air Forces as an Engineering Cadet. He was formerly an Instructor at the Army Division of the Boeing School of Aeronautics.

Charles Chin has transferred from the Airplane Division of Curtiss-Wright Corporation to Chance Vought Aircraft Division of United Aircraft Corporation as Structures Engineer.

Frank T. Coffyn has been promoted from Expeditor to Safety Engineer with The Liquidometer Corporation.

Robert C. Curry, an Instructor in Aeronautical Engineering at Casey Jones School of Aeronautics, has entered the U.S. Army.

Frederick P. Dillon, former Senior Research Engineer at Lockheed Aircraft Corporation, has entered the service of the Bureau of Aeronautics of the U.S. Navy.

Philip P. Dolin joined the Engineering Department of Goodyear Aircraft Corporation.

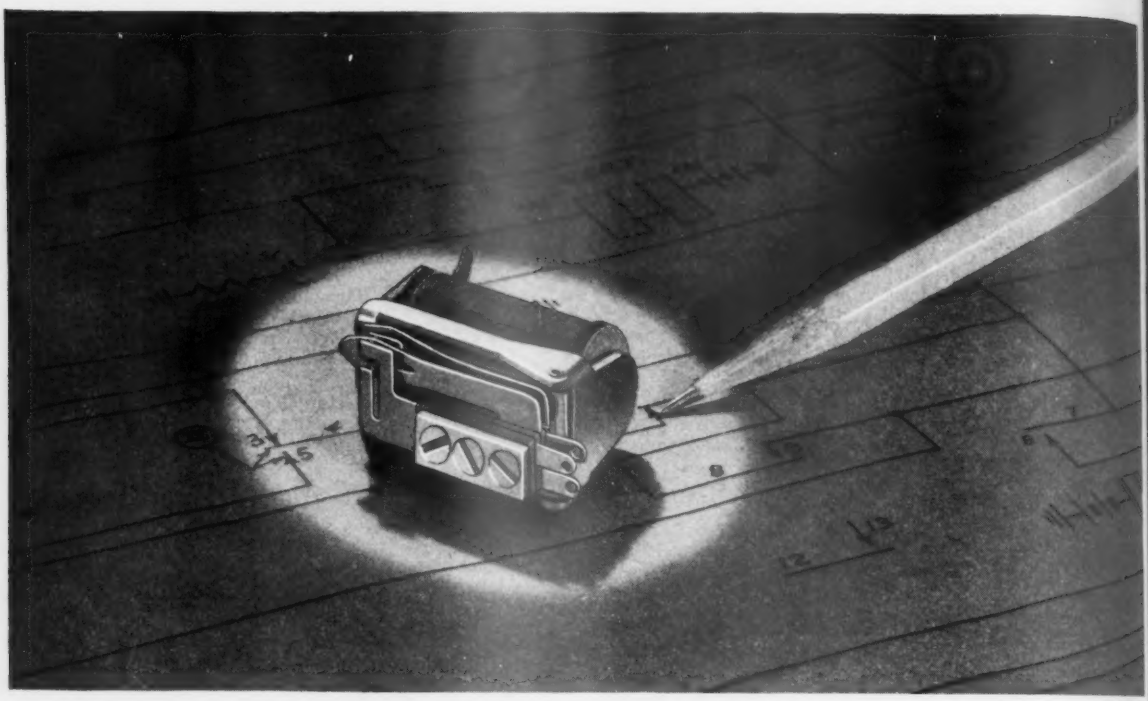
Otto V. Dunhofer is now Chief Engineer in Charge of Wind Tunnels in the Technical Service of the Brazilian Air Ministry.

Francis C. Dupree was promoted to Assistant Superintendent of Assembly at the Kollsman Instrument Division of the Square D Company.

Joe Austin Fisher, a Draftsman with North American Aviation, Inc., has entered the U.S. Army.

Bruce F. Grimm, Jr., is now a Stress Engineer with Avion Incorporated. He was formerly with the Fisher Aircraft Unit of General Motors.

Robert W. Hambrook has been appointed Director of Training for Higgins Aircraft, Inc., having formerly been a



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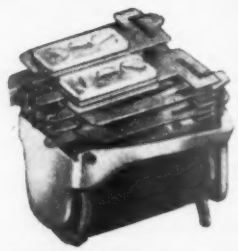

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Senior Specialist in the Office of Education of the Federal Security Agency.

Henry L. Hayes, formerly Stress Analyst with Bristol Aircraft Division of Universal Moulded Products Corporation, has joined the Cessna Aircraft Company in a similar capacity.

Henry Hochfeld has been appointed Chief of the Engineering and Experimental Department of the Aeronautical Engineering Division of Associated Foundries & Manufacturers, Inc.

Edgar M. Horwood has joined Boeing Aircraft Company as a Layout Engineer.

Charles M. Kearns, Jr., was advanced to Chief Research Engineer with the Hamilton Standard Propellers Division of the United Aircraft Corporation.

Howard F. Kirk, Jr., an Ensign in the U.S. Naval Reserve, has been assigned as Assistant Engineering Officer in the Lighter-Than-Air Squadron.

Bruce G. Leighton, former President of Intercontinent Aircraft Company and recently Special Assistant to the Production Vice-Chairman of the War Production Board, has been made the head of the Production Branch in the Office of General Inspector of Naval Aircraft.

Wendell W. Lowry, former Instructor at Indiana Technical College, has received his commission as an Ensign in the U.S. Naval Reserve.

Edward W. Murphy, recently District Maintenance Supervisor of the Civil Aeronautics Administration, has been appointed Air Carrier Inspector of Maintenance in the Air Carrier Branch of the Civil Aeronautics Administration.

M. F. Newmark, Jr., is now Chief Liaison Engineer of the Modification Center of Bechtel-McCone-Parsons Aeronautical Division.

Harlan V. Outman, Jr., formerly Chief Research Engineer at The Glenn L. Martin Company, has joined McDonnell Aircraft Corporation.

Albert C. Reed became Chief of Flight and Aerodynamics and Chief Test Pilot with Supervision of Flight Test, Aerodynamic Design, and Engineering Field Service with Avion Incorporated.

Thomas B. Rhines has been promoted to Chief Production Engineer at Hamilton Standard Propellers Division of United Aircraft Corporation, having formerly been Assistant Engineer.

Samuel T. Robinson is now the Manager of the Sales Research Division of Wright Aeronautical Corporation.

Dexter Rosen has joined Bell Aircraft Corporation as Senior Data Reduction Engineer in the Flight Research Division.

Ronald H. Smith, having graduated from the Massachusetts Institute of Technology, has joined the Douglas Aircraft Company, Inc., as a Designer.

Myrvel A. Sorenson has taken a military leave of absence from the Diesel Engine Division of General Motors Corporation to join the U.S. Navy.

Wesley A. Steyer is a Development Engineer with Goodyear Aircraft Corporation.

Earl J. Swailes, who for the past seven years has been an Inspector with the Bureau of Aeronautics, U.S. Navy, is now Chief Inspector for American Aviation Corporation.

Russell W. Thaw, recently Chief Test Pilot at the Louisville Plant, has joined the Fisher Cleveland Aircraft Division of General Motors Corporation as Director of Flight.

Joseph van Damme, formerly Junior Research Engineer with the National Research Council of Canada, has been commissioned a Sub Lieutenant with the Royal Canadian Navy Volunteer Reserve.

John E. Viscardi has entered the service of Columbia University as an Engineer in the S. A. M. Laboratories, Division of War Research.

Robert H. Wendt, formerly Chief Engineer of Taylorcraft Aviation Corporation, has been elected a Vice-President of the corporation. He will have charge of all engineering research and experimental activities of the company.

Robert L. Whitelaw, formerly Resident Inspector of the British Air Commission at the American Central Manufacturing Corporation, has been assigned to the New York Office as Assistant Inspector-in-Charge of the Aircraft Group.

Sing-fuh Yui has joined the Consolidated Vultee Aircraft Corporation as a Stress Analyst.

Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted to membership in the grades indicated since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Bennett, James Allan Jamieson, D.Sc.; Principal Technical Officer, British Air Commission.

Hutchinson, Lester Bowser, A.B. in M.E.; Chief of Engineer Laboratories, Brewster Aeronautical Corp.

Elected to MEMBER Grade

Barfoot, Joseph Earl, B.S. in C.E.; Strength & Tests Engineer, Douglas Aircraft Co., Inc.

Gordon, Carroll Gary, B.S. in M.E.; Design Engineer, Franklin Institute.

Gray, Howard Hutchins, B.S. in M.E.; Jr. Design Engineer, Lockheed Aircraft Corp.

Holgate, Thomas Amherst, B.S. in C.E.; Aerodynamicist, The Glenn L. Martin Co.

Johnston, William Saunderson, Lt. Col., U.S. Army Air Forces; Army Air Forces Resident Rep.

Keller, Ernest George, Ph.D.; Consulting Engineer, Lockheed Aircraft Corp.

King, Walter Bennett, B.S. in M.E.; Instructor, Oklahoma A. & M. College.

Margwarth, John Alfred, B.S. in Ae.E.; Sr. Research Engineer, Lockheed Aircraft Corp.

Pelzel, Robert E., M.S. in Chem; Mat. & Processes Consultant, Douglas Aircraft Co., Inc.

Simmons, Edward Ernest, Jr., M.S. in E.E.; Signal Section, War Dept.

Whitney, Charles Smith, M.C.E.; Consulting Engineer.

Transferred to MEMBER Grade

Ivanovic, Nicholas, B.S. in M.E.; Aero. Engineer, Naval Aircraft Factory, Navy Yard, Philadelphia.

Lesher, Edgar, M.S. in Ae.E.; Asst. Prof., University of Michigan.

Sepulveda-Riveros, Luis Alfredo, B.S. in Ae.E.; Lt. & Engineer, Chilean Air Force.

Sherwin, Samuel B., M.Ae.E.; Structural Development Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Elected to Technical Member Grade

Archbold, Edward John Nicholas, B.Sc. in Ae.E.; Technical Asst., Handley Page Ltd., England.

Baer, Jerome Charles, Jr., Preliminary Tool Engineer, Boeing Aircraft Corp.

Bessent, Carl Francis, B.S. in M.E.; Lt., U.S. Army Air Forces; Experimental Engineering Section, Wright Field.

Bird, Ronald Edward, Asst. Stress Designer, Taylorcraft Aeroplanes Ltd., England.

Blackmore, Don Milton, Service Design Engineer, Vega Aircraft Corp.

Cesarini, Julius, B.C.E.; Layout Engineer, Andover Kent Aviation Corp.

Coffman, Alfred C., Field Engineer, Goodyear Aircraft Corp.

Coward, Kenneth S., B.S. in Ae.E.; Stress Analyst, Boeing Aircraft Co.

Davison, George Stewart, II, Research Engineer, Bell Aircraft Corp.

Erickson, Myles Delane, B.S. in Ae.E.; Asst. Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Horowitz, David, Stress Analyst, York Aircraft Corp.

Hummel, Louis F., Service Engineer, Sikorsky Aircraft Div., United Aircraft Corp.

Jackson, Roy Peter, A.B. in M.E.; Assoc. Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Janes, Constantine J., B.Ae.E.; Asst. in Development Projects, C.A.A.

Mead, Thomas H., Layout Draftsman, Engineering, Hughes Aircraft Co.

Paolini, August Mario, B.S. in Ae.E.; Engineer, Boeing Aircraft Co.

Penn, David L., Development Engineer, Lockheed Aircraft Corp.

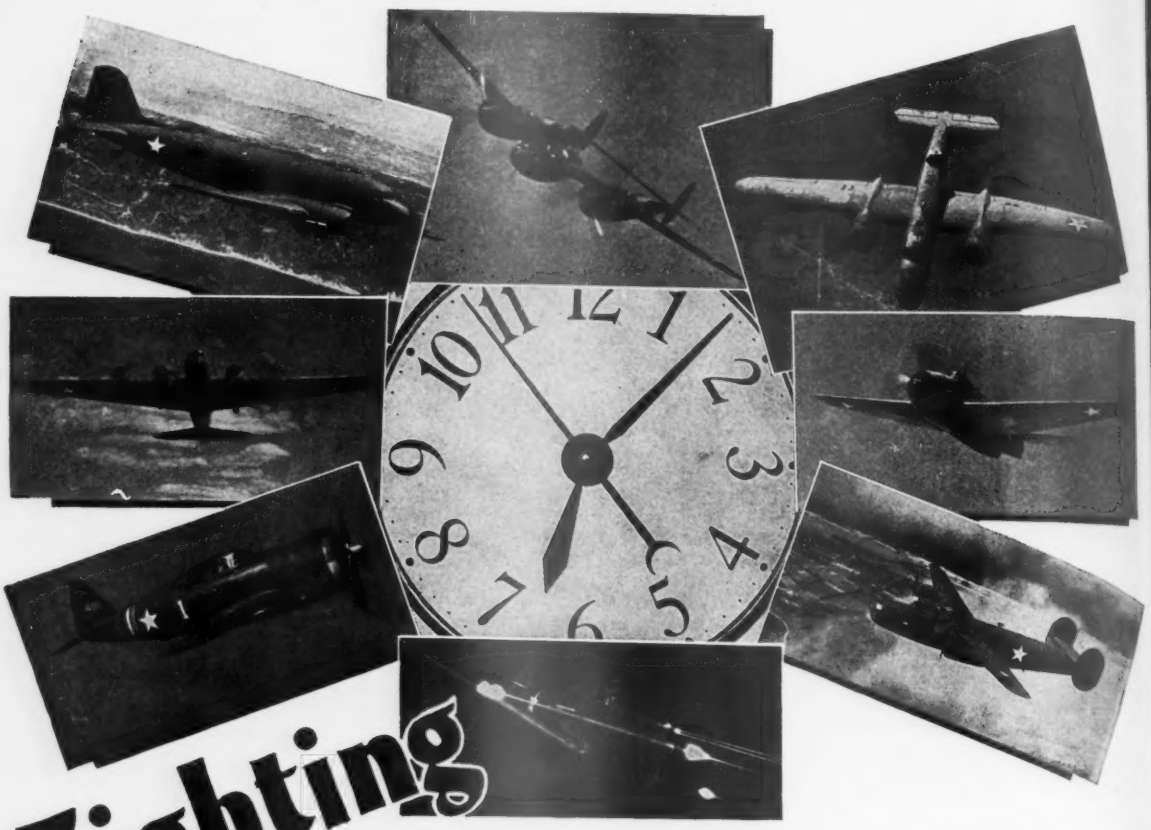
Redinger, Jack, B.S. in Ae.E.; Test Engineer, Boeing Aircraft Co.

Stapelfeld, Wilfred Paul, B.S. in C.E.; Stress Engineer, Grumman Aircraft Engineering Corp.

Toppel, Milton, B.S.; Flight Test Engineer, Airplane Div., Curtiss-Wright Corp.

Waldron, Robert Edwards, B.S. in Ae.E.; Aero. Engineer, Airplane Div., Curtiss-Wright Corp.

Wolcott, Charles Gordon, B.S. in M.E.; Aerodynamicist Trainee, Consolidated Vultee Aircraft Corp.



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Transferred from Student to Technical Member Grade

Allrud, Ralph Gordon, B.S. in Ae.E.; Jr. Engineer, Lockheed Aircraft Corp.

Anderson, Archibald Lamon, Jr., B.S. in Ae.E.; 2nd Lt., U.S. Army Air Forces.

Anderson, Warren A., B.Ae.E.; Engineering Trainee, North American Aviation, Inc.

Ankenbruck, Herman O., B.S. in A.E.; Jr. Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Asher, Norman John, B.S. in Ae.E.; Research Engineer, Princeton Univ.

Baer, John David, A.B. in G.E.; Jr. Engineer, Lockheed Aircraft Co.

Balunas, Vincent Joseph, Jr., B.S. in Ae.E.

Berman, Herbert, B.S. in Ae.E.; Aero. Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Bizar, Howard S., B.A.; Designer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Blakeslee, Franklin Philip, B.S. in Ae.E.; Aviation Cadet, U.S. Army Air Forces.

Brannon, Ward, Ae.E.; B-Layout Draftsman, The Glenn L. Martin Co.

Bremer, Frank Emil, Jr., B.Ae.E.; Apprentice Engineer, Pan American Airways System.

Bridgland, Edgar Parsons, A.E.; Flight Lt., Personal Staff Officer, R.C.A.F.

Brown, Wilbur, B.S. in Ae.E.; Stress Analyst, Douglas Aircraft Co., Inc.

Browne, Paul E., B.S. in M.E.; Ensign, U.S. Navy.

Bruman, Joseph Raymond.

Buchman, Walter Harold, Ae.E.; Project Engineer, Taylorcraft Aviation Corp.

Burkheimer, George E., B.S. in Ae.E.; Aerodynamic Research Engineer, Consolidated Vultee Aircraft Corp.

Carroll, Emil Richard, M.E.; Aviation Cadet, U.S. Army Air Forces.

Cavanagh, Robert Lindsay.

Charyk, Joseph Vincent, M.S. in Ae.; Graduate Asst., Calif. Inst. of Tech.

Culp, Claude Richard, B.S. in Ae.E.; Stress Analyst, Douglas Aircraft Co., Inc.

Dailey, Vance Covell, B.Ae.E.; Ensign, U.S.N.R.

Dauwalter, Chadwick Schuyler, Ae.E.; Sr. Engineering Asst., Vega Aircraft Corp.

De Vault, Robert Tenney, B.S. in M.E.; Aerodynamicist, Northrop Aircraft, Inc.

Dolfi, Harry William, B.S. in M.E.

Drake, John Archibald, M.S.; Flight Test Engineer, North American Aviation, Inc.

Dunhofer, Hans Veiga, Ae.E.; Aero. Engineer, Brazilian Air Ministry, Brasil.

Eley, Herman Odis, Jr., Jr. Stress Engineer, McDonnell Aircraft Corp.

Fierle, Wilfrid Anthony, B.Ae.E.; Jr. Service Engineer, Airplane Div., Curtiss-Wright Corp.

Fiul, Abraham, B.S.; Aerodynamicist, Consolidated Vultee Aircraft Corp.

Forrest, Clarence Lyman, B.S. in Ae.E.; Research Aerodynamicist, Bell Aircraft Corp.

Foster, Charles Richard, B.S. in M.E.; Officer Candidate School, U.S. Army Air Forces.

Gasich, Welko Elton, A.B. in Ae.E.; Engineer, Douglas Aircraft Co., Inc.

Glascock, James Landis, B.S. in Ae.E.; Jr. Engineer, Airplane Div., Curtiss-Wright Corp.

Gravelle, Paul Edward, Stress Analyst, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Guy, Donald Bobbitt, B.S. in Ae.E.

Heflin, Ross Eugene, B.S. in Ae.E.

Hill, Thomas Burton, Jr., B.S. in M.E.; Ensign, U.S.N.R.

Hollinshead, Glen Donald, B.S.E.; Flight Research Engineer, Bell Aircraft Corp.

Hughes, Kenneth Michael, B.S. in Ae.E.; Jr. Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Huntsberger, Ralph Francis, Jr., A.B. in Ae.E.; Asst. Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Jevas, Nicholas, B.S. in Ae.E.; Jr. Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Jonas, Hymen, B.S. in Ae.E.

Jones, Arthur Lincoln, B.Ae.E.; Jr. Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Judson, George Eugene, Jr., B.S. in M.E.; Liaison Engineer, Douglas Aircraft Co., Inc.

Kane, Richard Francis, M.A. & Prof. Degree in Ae.E.; Lt. Comdr., U.S. Navy.

Kepple, William Lloyd, B.Ae.E.; Jr. Aero. Engineer, Aircraft Engine Research Lab., N.A.C.A.

King, Edward Jower, B.S.

Knowles, Samuel Givens, B.A. in C.E.; Stress Analyst, Douglas Aircraft Co., Inc.

Kolbe, Carl Devoux, B.S. in Ae.E.; Jr. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Kolom, Aaron Leigh, B.S. in M.E.; Member of Stress Group, North American Aviation, Inc.

Kurrasch, Leslie Franklin, B.Ae.E.; Jr. Engineer, El Segundo Div., Douglas Aircraft Co., Inc.

Lindquist, Donald Raefield, B.S. in Ae.E.

Major, Leland Sydney, Ae.E.; Private, U.S. Army.

Martin, Lincon A., M.S.; Aerodynamicist, El Segundo Div., Douglas Aircraft Co., Inc.

McEwan, James Donald, B.S. in Ae.E.; Aviation Cadet, U.S. Army Air Forces.

Milwitzky, Benjamin, B.Ae.E.; Jr. Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Myers, Dale DeHaven, B.S. in Ae.E.; Aerodynamicist, North American Aviation, Inc.

O'Neill, James Eugene, B.S. in M.E.; Jr. Engineer, Aerodynamics Dept., McDonnell Aircraft Corp.

Overbey, Charles Albert, Ae.E.; Aviation Cadet, U.S. Army Air Forces.

Page, Ralph Edward, Jr., B.S. in M.E.; Experimental Test Engineer, Pratt & Whitney Aircraft Div., United Aircraft Corp.

Pound, Claude Patrick, Jr., B.S. in Ae.E.; Engineer, Taylorcraft Aviation Corp.

Powell, Albert Vincent, B.S. in Ae.E.; Student Engineer, Douglas Aircraft Co., Inc.

Pursifull, L. J., B.S. in Ae.E.; Langley Mem. Aero. Lab., N.A.C.A.

Quan, Andrew Sydney, B.S.E.; Engineering Trainee, El Segundo Div., Douglas Aircraft Co., Inc.

Riley, Brent Abbot, B.Ae.E.; Corporal, U.S. Army Air Forces.

Roden, Berkeley C., B.S. in Ae.E.

Rothgeb, Earl P.

Saari, Martin John, B.Ae.E.; Jr. Aero. Engineer, Aircraft Engine Research Lab., N.A.C.A.

Schroder, Edward W., B.A.E.; Designer, Ford Motor Co.

Shields, Edward Beverly, Jr., B.S. in M.E.; Engineer, Pan American Airways System.

Simanonis, Florian Joseph, B.S. in Ae.E.; U.S. Army Air Forces.

Stephens, Robert Luther, B.S. in Ae.E.; 2nd Lt., U.S. Army.

Stirling, Cedric Warren, M.S. in Ae.E.; Lt. Comdr., U.S. Navy.

Swanson, Warren Ernest, B.S. in Ae.E.; Ensign, U.S.N.R.

Tarsia, Frank, B.Ae.E.; Draftsman, Chance Vought Aircraft Div., United Aircraft Corp.

Tollisen, Herbert Logan, Jr., B.S. in M.E.; Engineer, Alaska Div., Pan American Airways System.

Van Norde, Peter Jack, B.S. in Ae.E.

Weiler, Henry Francis, A.E.; Engineer, Aeronca Aircraft Corp.

Weiss, Joseph Harry, B.S. in Ae.E.; Detail Draftsman, Consolidated Vultee Aircraft Corp.

Wiethoff, John Peter, Ae.E.; Ensign, U.S.N.R.

Williams, Max Lea, Jr., B.S. in M.E.; 2nd Lt., Engineering Officer, U.S. Army Air Forces.

Woodbury, James Roy, B.Ae.E.; Engineer, Douglas Aircraft Co., Inc.

Zmitrovich, Constantine, B.A.E.; Private First Class, R.O.T.C.

Elected to Affiliate Grade

Dunlap, Doris Anna, B.S.

Folt, Andre, President, A. & M. Accessories Ltd., Canada.

Hyde, Theophilus Rodgers, M.A. in M.E.; Lt. Comdr., Officer in Charge of Ground School, U.S. Navy.

Clark, Edward G., Power Plant Engineer, Grumman Aircraft Engineering Corp.

Connors, Richard Birmingham, B.S.; Jr. Pilot, Pan American Airways System.

Zimmerman, Norman Herbert, B.S. in M.E.; Lt., Asst. Experimental Engineering Officer, U.S. Army Air Forces.

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Twelfth Annual Meeting

Institute of the Aeronautical Sciences

January, 1944

The Officers and Council of the Institute invite individual members and manufacturing and technical organizations to consider participation in the Twelfth Annual Meeting to be held during the last week in January, 1944. The time and place of all technical sessions will be announced later.

Technical sessions are now being planned in the following fields:

Aerodynamics
Airplane Design
Aircraft Production
Air Transport
Materials (Ferrous, Nonferrous, Organic, and Synthetic)
Meteorology
Power Plants and Propellers
Radio and Instruments
Rotating-Wing Aircraft
Physiologic Problems
Structures

The meetings committee will consider for inclusion on the program either complete papers or outlines or summaries of proposed papers.

All correspondence should be addressed to:

The Secretary
Institute of the Aeronautical Sciences
1505 RCA Building West
30 Rockefeller Plaza
New York 20, N. Y.

Information for Participants

(1) Outlines or complete papers should be submitted in duplicate on or before October 1. Outlines or summaries should not exceed 1,000 words.

(2) Each paper should be so planned that it may be presented orally within a time limit of 30 minutes.

(3) All papers submitted will automatically be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*. While a paper should be planned to take only 30 minutes for oral presentation, the written presentation may have a maximum length of approximately 20,000 words.

(4) All material received will be submitted to the meetings committee. Authors will be notified, in ample time to prepare the complete paper, as to whether or not their papers can be scheduled for presentation.

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Farsighted airport operators will find Shell's wartime popularity a profitable peacetime asset.
AVIATION FUELS
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Necrology

Joseph Sweetman Ames

Joseph Sweetman Ames, one of the small group that organized and founded the Institute, and an Honorary Fellow since 1932, passed away on June 24, 1943, in Baltimore. He was President Emeritus of Johns Hopkins University and former Chairman of the National Advisory Committee for Aeronautics.

During the 24 years which he served on the National Advisory Committee for Aeronautics, Dr. Ames probably contributed more than any other man to the development of the science of aeronautics in this country. One of the original members of the N.A.C.A. appointed in 1915 by President Wilson, Dr. Ames served as Chairman of the Executive Committee of the N.A.C.A. from 1919 to 1936, as Chairman of the main committee from 1927 to 1939, and at different times on more than 20 of its subcommittees. The patriotic and generous public-minded spirit with which Dr. Ames made his numerous contributions to the Committee is brought out by the fact that he served all of these years without pay.

The fact that few people know of Dr. Ames' many achievements and contributions is attributable to the quiet and modest way in which he conducted both his own affairs and those of the N.A.C.A. Few men before their death have been so deservedly honored as was Dr. Ames. Shortly after his resignation as Chairman of the N.A.C.A. in 1939 because of failing health, Dr. Ames was informed that the new N.A.C.A. $16,000,000 aeronautical research laboratory at Moffett Field, Calif., was to be named the "Ames Aeronautical Laboratory" in his honor. This laboratory, the second aeronautical research station of the N.A.C.A., now plays a vital role in the world-wide struggle for qualitative supremacy in aircraft.

In accepting Dr. Ames' resignation on October 10, 1939, President Roosevelt wrote:

> "For the past twenty years you have served as Chairman of the National Advisory Committee for Aeronautics or Chairman of its Executive Committee. The administration and the accomplishments of the Committee under your leadership reflect your great scientific attainments, professional courage, and executive ability.
>
> "That the people generally have not known of your brilliant and patriotic service is because it has been overshadowed by your passion for accomplishment without publicity. But the fact remains, and I am happy to give you credit for it, that the remarkable progress for many years in the improvement of the performance, efficiency, and safety of American aircraft, both military and commercial, has been due largely to your own inspiring leadership in the development of new research facilities and in the orderly prosecution of comprehensive research programs."

Dr. Joseph S. Ames

Members of the Air Commands of the Army and Navy placed great faith in Dr. Ames and followed his inspiring leadership in the prosecution of aeronautical research directed to keeping America ahead of other nations in the design of airplanes. Among the signers of a testimonial resolution recognizing the great work of Dr. Ames, adopted at the October 19, 1939, meeting of the N.A.C.A., were the following responsible chiefs of military aeronautics: Lt. Gen. Henry H. Arnold, now Commanding General of the Army Air Forces; Lt. Gen. George H. Brett, formerly Chief of Air Operations in the Southwest Pacific under General McArthur and now Army Air Commander in the Caribbean area; and Vice-Admiral John H. Towers, formerly Chief of the Navy Bureau of Aeronautics and now Chief of Air Operations in the Pacific. This resolution stated:

> "For over twenty years Dr. Ames has served as Chairman of the National Advisory Committee for Aeronautics or as Chairman of its Executive Committee. His long service leaves upon the organization the indelible imprint of his character. He is not only a great scientist, he is a great man, and we are proud to have been associated with him.
>
> "When aeronautical science was struggling to discover its fundamentals, his was the vision that saw the need for novel research facilities and for organized and sustained prosecution of scientific laboratory research. His was the professional courage that led the Committee along new scientific paths to important discoveries and contributions to progress that have placed the United States in the forefront of progressive nations in the development of aeronautics. His was the executive ability and far-sighted policy of public service that, without seeking credit for himself or for the Committee, developed a research organization that holds the confidence of the governmental and industrial agencies concerned and commands the respect of the aeronautical world. Withal, Dr. Ames was an inspiring leader of men and a man beloved by all his colleagues because of his rare personal qualities."

Dr. Ames' scientific knowledge and professional attainments are exemplified by the fact that for many years he was an outstanding physicist on the faculty of Johns Hopkins University, and for the latter part of his career, served as president of that great educational institution.

Other public honors came to Dr. Ames. In 1923 he was invited to present the Wilbur Wright Memorial Lecture before The Royal Aeronautical Society of Great Britain. In 1935 he was presented the Langley Gold Medal for Aerodromics by Mr. Chief Justice Charles Evans Hughes, then Chancellor of the Smithsonian Institution, in recognition of the "surpassing improvement of the performance, efficiency and safety of American aircraft resulting from fundamental scientific research conducted by the National Advisory Committee for Aeronautics under the leadership of Dr. Ames."

Much credit for the many outstanding accomplishments of the N.A.C.A. must also be given to Dr. Ames, for it was under his courageous leadership that the foundation for the progress in airplane design now being realized was laid. In 1930, the N.A.C.A. was awarded, by President Hoover, the Collier Trophy for having made during the previous year "the greatest achievement in aviation" in the development of the N.A.C.A. cowling.

A glance at a group of modern airplanes on almost any American airport would bring into view many features developed by the Committee under the guidance of Dr. Ames. The famous N.A.C.A. cowling for radial air-cooled engines, the N.A.C.A. low-drag wing, the proper location of engines and nacelles in the wing of an airplane, the size and location of the control surfaces, the tricycle landing gear, and the general streamlining and contour of the modern airplane represent results of work done in the laboratories of the Committee.

With the nation now involved in a global war in which air power is a dominant factor, the work done by Dr. Ames in improving the efficiency and performance of our aircraft over a period of more than 20 years is of inestimable value to his country.

The following editorial comment appeared in *The New York Times* for June 26, 1943:

> "The world of scholarship has lost a leader and the world of aeronautics a staunch and far-seeing friend in the death of Dr. Joseph S. Ames. For more than fifty years he was associated with Johns Hopkins University in active capacities, which ran the gamut from student to president. As dean and provost, as well as chief executive, he had a vital influence on

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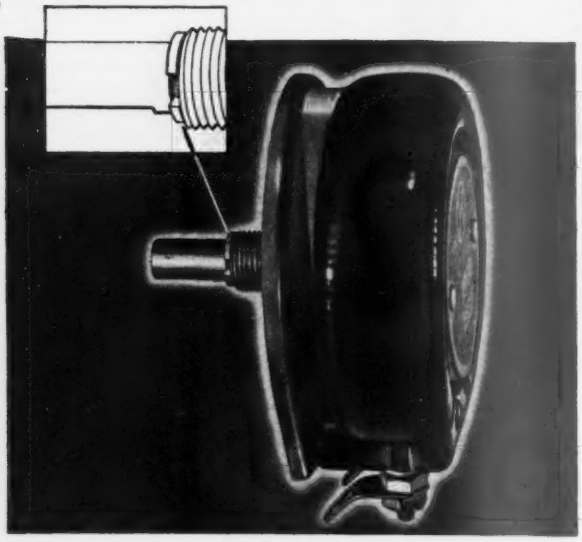

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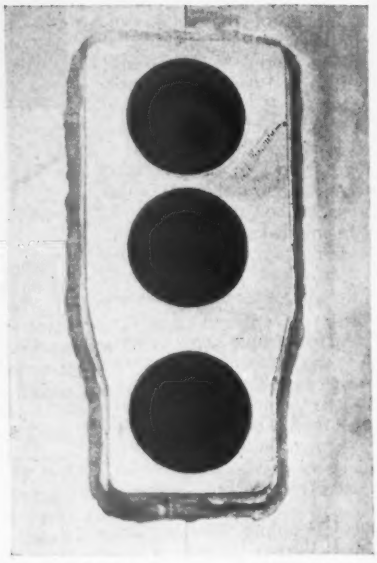

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SPECIFICATIONS

Army Air Forces	11351
U. S. Navy, Bureau of Ships	46A1, Class 1
U. S. Navy, Bureau of Aeronautics . . .	(Pending)

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the development of that institution through its rise to the forefront of American universities.

"Long the head of the Physics Department at Johns Hopkins, Dr. Ames brought a deep curiosity and a pioneering spirit to all matters which touched upon his specialty. These were qualities which enabled him to render distinguished service to the nation as chairman, from 1927 to 1939, of the National Advisory Committee for Aeronautics, of which he had been a member since 1917. It is not too much to say that his leadership in the development of the Langley Memorial Laboratory and his explorations there in fundamental aeronautical research, with the collaboration of Dr. George W. Lewis and the able staff which they assembled, were invaluable contributions to the qualitative superiority of American aircraft and engines on which we depend so heavily today."

Lt. Col. William Alfred Bevan

Lt. Col. William Alfred Bevan, U.S. Army Air Corps Reserve, an Associate Fellow of the Institute, died after a long illness at his home in Mooresville, Ind., on July 5, 1943, at the age of 67.

Born at Skewan, Wales, Great Britain, on December 11, 1876, he came to the United States in 1882 and became an American citizen in 1895. His Bachelor of Science degree was conferred by Iowa State College in 1904, his Master of Arts was earned at Massachusetts Institute of Technology in 1921, and his Bachelor of Science in Mechanical Engineering was taken at Purdue University in 1926.

Colonel Bevan rose from the ranks in the U.S. Army, having enlisted as a private in the Aviation Section of the Signal Reserve Corps in 1917, serving throughout the first World War at the Army School of Aeronautics at M.I.T.; at Mather Field, Sacramento, Calif.; at the Special School on Liberty Motors at Detroit; and at other Army aviation centers. He graduated from Mather Field Flying School with the rating of Reserve Military Aviator in 1919, was rated an Aviation Pilot on January 1, 1920, and was commissioned a Captain in the Air Service of the Regular Army on July 1, 1920. He continued as Chief Engineer at various air stations in the United States and in Hawaii until 1922, when he was discharged from the Regular Army at his own request and commissioned a Major in the Air Corps Reserve in 1924.

Returning to active duty as Commanding Officer of the 309th Observation Squadron and assigned to various other units, he served at Wright Field from 1924 to 1936, having been made a Lieutenant Colonel in 1930. Colonel Bevan's work since leaving the Regular Army included terms as Instructor in Aeronautics at Culver Military Academy, Assistant and Associate Professor of Aeronautical Engineering at Purdue University, and Professor of Aeronautical and Mechanical Engineering at Iowa State College.

He contributed numerous articles and papers on aeronautical subjects to the *Proceedings of the Indiana Engineering Society*, the *Purdue Engineer*, the *Iowa Engineer*, and the *Proceedings of the Iowa Engineering Society*. In addition to his Associate Fellowship in the Institute of the Aeronautical Sciences, Colonel Bevan was a member of the Society of Automotive Engineers and of the Aeronautics Committee of the Association of Land Grant Colleges and Universities, and Technical Advisor to the Iowa Aeronautics Commission.

In March of this year, Colonel Bevan thoughtfully inquired whether the Aeronautical Archives would be interested in receiving the technical books in his personal library. They include more than three dozen books that were not previously in the Archives and have now been made a part of its great collection.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Research Engineer with training in electrical engineering and physics; experience in development or research on electrical devices and equipment with a major industry; design and aircraft experience desirable; for West Coast employment by essential war industry. Address inquiries to Box 186, Institute of the Aeronautical Sciences.

Aeronautical Engineers urgently needed by Consolidated Vultee Aircraft Corporation, Fort Worth Division, to execute program of extensive development of large aircraft. Applicant must have technical training and not presently employed in essential war industries. Apply direct to 921 Lamar Street, Fort Worth, Tex.

Graduate Engineers for essential war work, opportunity for advancement and increased earnings. Aeronautical experience not necessary. Must be citizen not employed in essential war industry or have certificate of availability from the U.S. Employment Service Office or War Manpower Commission of your area. Write direct stating school, age, degree, experience, draft classification and marital status to Consolidated Vultee Aircraft Corporation, Industrial Training Division, San Diego, Calif.

Two Assistant or Associate Professors: (a) Instructor aircraft detail design and structural layout; (b) Instructor preliminary airplane design. Both positions are to fill existing vacancies in the regular staff. Each must have his or her degree in aeronautical engineering together with practical experience in the aircraft industry. Teaching experience desirable but not necessary. Rank and salary depend upon qualifications. Address inquiries to Dean Robert L. Mann, Spartan College of Aeronautical Engineering, Tulsa, Oklahoma.

Aeronautical Engineer; should be interested in future of air freight transportation, capable appraising current aircraft design for cargo ships and able to contribute practical ideas for sound development of efficient, coordinated air and ground handling service. Headquarters New York City; not a manufacturer. Reply stating age, draft status, qualifications, and salary to Box 192, Institute of the Aeronautical Sciences.

AVAILABLE

Aeronautical Engineer (B. of Ae.E.) 6 years' experience aircraft power-plant installation design, layout, supervision, shop contact, liaison, field work for many first rate military aircraft; aircraft shop experience as mechanic and inspector. Desires position in supervisory design capacity or as engineering representative with power-plant accessory manufacturer or as group engineer on power plants with aircraft manufacturer. Address inquiries to Box 155, Institute of the Aeronautical Sciences.

Engineer long experience in aircraft design and manufacture; specialized training in application of plastics to aircraft manufacturing desires permanent or consulting connection. Address inquiries to Box 188, Institute of the Aeronautical Sciences.

Engineer, Senior Aeronautical and Physicist (Ph.D.), 15 years' experience, available as consultant. Address inquiries to Box 189, Institute of the Aeronautical Sciences.

Engineer, B.S. in Ae.E., over 8 years' experience as test pilot including planning of tests and analysis of results, desires position primarily utilizing flight and engineering experience but not involving routine test flying. Some flying desirable. Address inquiries to Box 190, Institute of the Aeronautical Sciences.

Aeronautical Engineer, B.S. in Ae.E., 8 years' experience, both military and commercial aircraft; experienced in all phases of design and design supervision. Desires position of staff or design engineer in controls or assistant project engineer. Position must have postwar future. Address inquiries to Box 191, Institute of the Aeronautical Sciences.

BOEING STRATOLINER

Constant voltage protection all the way

Ask the men who produce planes and the men who pilot them. They'll tell you what vital part *constant voltage* plays in modern aviation. In the sky, it's *constant voltage* on the directional beam which guides the ships through night and storm. In the shop, it's *constant voltage* on the production line which maintains the split-hair accuracy of precision airplane parts.

For the aircraft industry—*and for your own*—SOLA CONSTANT VOLTAGE TRANSFORMERS provide this all-important stabilized power. They stand between costly equipment and destructive voltage fluctuations now common on overloaded power lines. Without supervision they instantly absorb power sags and surges as great as 30%.

For unerring operation of precision tools, and protection of almost irreplaceable instruments and electronic tubes, put SOLA CONSTANT VOLTAGE TRANSFORMERS on duty in your plant. They're built in standard units from 10 VA to 15 KVA capacity—self-protecting against short circuit and without moving parts. Special units can be built to specification.

Note to Industrial Executives: *Find out how Sola "CV" transformers can solve voltage control problems in your operations. Send for bulletin 9CV-7A.*

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Services of the Aeronautical Archives of the Institute of the Aeronautical Sciences

The services of the Aeronautical Archives are available to all members of the Institute, to Corporate Members, to advertisers in the AERONAUTICAL ENGINEERING REVIEW and, under usual library limitations, to the public. Four specialized services are available.

The Paul Kollsman Library

This lending library service makes available, *without charge*, the latest and more important aeronautical books.

As far as the facilities permit, any person in the United States over 18 years of age who can furnish references that certify to his or her responsibility may become a member of the library.

Members may request the loan of any aeronautical or technical book they wish to borrow. Through an exchange agreement with the Engineering Societies Library, any book on general engineering may be borrowed from its great collection of over 160,000 volumes.

A photostating service is available at usual library rates.

Applications for membership in the library and further information will be sent on request.

The Burden Reference Library

This reference library contains over 14,000 aeronautical books, magazines, pamphlets, photographs, reports, and clippings gathered from world-wide sources and is one of the most complete aeronautical libraries in the world. Material from this library is not available for loan but may be used for reference purposes at the Aeronautical Archives.

The Pacific Aeronautical Library

6715 Hollywood Boulevard
Hollywood, California

Established in cooperation with the aircraft companies the library serves. The leading aircraft companies in or near Los Angeles participate in its support and operation.

This service library for aeronautical research is available to the public for reading privileges. Source material includes aerodynamic and structural research reports, as well as books on drafting, production methods, history, and allied sciences. It furnishes books, periodicals, and pamphlet material to the participating aircraft companies to supplement their engineering libraries.

The Aeronautical Archives Technical Information Service

This service has experienced personnel under the supervision of trained aeronautical engineers to compile any information desired. The services range from listing specialized reference books to the preparation of exhaustive bibliographies, digesting of reports, and general surveys of any aeronautical subject. Some of the available services are:

Bibliographies on any aeronautical subject.
Reports on any aeronautical subject.
Digests of aeronautical books, papers, periodicals, and references.
Translations.
Engineering investigations of special aeronautical subjects.
Biographies of individuals engaged in aeronautics.
Photostats of any aeronautical or general engineering material.
Microfilms made on special order.
Photographs made from the Institute's photographic collection.
Drawings and tracings made.

In addition to the services mentioned any commission which comes within the scope of the Service will be accepted. Special arrangements may be made for work requiring several weeks or months.

Translators are available for accurate transcriptions of all foreign language data. Translations are carefully edited by trained engineers.

Reproductions of any material in the Aeronautical Archives of the Institute may be ordered at standard photostat rates.

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Institute of the Aeronautical Sciences

List of Aeronautical Films Available for Loan to Sections and Branches

THE FOLLOWING LIST of motion-picture and slide films that can be obtained for meetings of local Sections and Student Branches of the Institute will be brought up to date from time to time as new pictures are available. An officer of the Branch or Section requesting a film should write on official stationery to the addresses and departments indicated above each group of films and accept responsibility for care and return of the films borrowed. He should be prepared to accept films by express collect and return them by express prepaid immediately after showing, as most films are loaned on these conditions. The lenders of films will appreciate a letter from the Branch or Section officer, notifying them of the return of film, date and place shown, and the number of persons in attendance. Reports of each meeting should also be sent to the Secretary of the Institute, giving titles of films shown and other items on the program. Please let the Secretary know the details of any aeronautical films, suitable for showing at our meetings, which are not on this list so that they can be added promptly and brought to the attention of other Branches and Sections.

The Institute invites any organization having instructional films available to send a brief listing to the Secretary for inclusion on this list. When copies of films can be sent to the Institute's film library, the Institute will directly service the Branches and Sections.

In showing borrowed films care should be taken to use only equipment in good condition handled by competent operators. Motion-picture films should *not* be rewound after showing. Sound films should be shown *only* on a sound projector, as the use of sound films on a silent projector will ruin them. Film strip projection slides, 35 mm., should be used on special projectors that are especially designed for this purpose.

Institute of the Aeronautical Sciences, Office of the Secretary, 1505 RCA Building West, 30 Rockefeller Plaza, New York 20, N.Y.

Keep 'Em Flying—16 mm., sound, 20 min. Hamilton Standard Propellers Division film showing operation of hydromatic type propellers and detailed procedure for installation and maintenance.

Lockheed 14—16 mm., silent, 20 min. Technical description of stalling characteristics of Lockheed 14 airplane.

Conquest of the Air—16 mm., sound, 40 min. Popular historical and descriptive film on how man learned to fly and development of the art to present day; includes diagrammatic exposition of how an airplane flies.

Development of the De-Icer—35 mm., slide film (not movie), 20 to 30 min.; 53 slides on projection strip with subtitles superimposed on pictures; reproduction of pictures furnished in accompanying booklet so that lecturer may read titles and add his own comments; produced in May, 1942. Describes causes and effects of icing on airplanes, research and development of equipment to combat it.

De-Icer Servicing and Installation—35 mm., slide film (not movie), 20 to 30 min.; 80 slides in same form as above. Details of installing, removing, storing, and repairing Goodrich De-Icing Equipment.

Goodrich De-Icer Development—16 mm., silent, 20 min. B. F. Goodrich Company film describing early stages in development of airplane deicing equipment.

De-Icers and Design—35 mm., slide film (not movie), 20 to 30 min. Explains to designers, engineers, and production personnel some of the basic steps and procedures, methods of installations, attachment devices, and aerodynamics of the deicer.

Cyclone Combustion—16 mm., sound, 25 min. Produced by Wright Aeronautical Corporation as an aid to pilots in obtaining maximum performance from their engines. Touches on the following topics: normal combustion; single and multiple ignition; the induction system; the effect on combustion of engine speed; manifold pressure; fuel-air ratio; temperature, rain, and altitude; the mechanism of detonation, preignition, and the control of detonation.

Streamlined—16 mm., sound, 40 min. (one reel). Produced by Thompson Products, Inc. Shows many scenes of auto races of a few years ago and its effect on engine design; news reel clips of early airplane flights, World War I and World II planes in combat, scenes at Randolph Field; description of processes in manufacture of Thompson valves, pumps, and other accessories for aircraft engines.

Army Air Forces Headquarters, Adjutant General, Photographic Section, Room 1047, Munitions Building, Washington, D.C.

Wings of the Army—Four reels, sound, 1 hour, available in 16 mm., and 35 mm., No. 24-S (state which). Depicts the story of the U.S. Army Air Corps from early flights by the Wright Brothers up to the operation of the latest and fastest type of military airplane. If desired, any one of the four reels can be shown separately and is a unit in itself. *Reel 1.* History—The Wright Brothers' first flights. The first Army Airplane. Curtiss, Bleriot, and Beachy. Air Corps Aviation in 1918. *Reel 2.* Peaceful Pursuits—Air Corps participation in Air Mail, Forest Patrol, Exploration, Development and Good Will Flights, Flood and Hurricane Relief. *Reel 3.* Materiel Division—Development and testing of airplanes and equipment. *Reel 4.* Training and Operations—Flying Cadet training and activities of the G.H.Q. Air Force.

Flying Cadets 1940—Four reels, sound, 1 hour, available in 35 mm., and 16 mm., No. 24-S (for 16-mm. size request No. 25-S-A). Depicts the training of Air Corps pilots from their entrance in Civil Schools conducted by Civil Aeronautics Administration to completion of flight training at Randolph and Kelly fields. This film shows most of the methods used in training military pilots.

Bell Aircraft Corporation, Motion Picture Division, 2050 Elmwood Ave., Buffalo, N.Y.

Cannons on Wings—16 mm., sound, color, 25 min., dealing with pursuit interceptor aircraft and its place in the war effort today; how the problem of personnel required to turn out planes in greatly increased numbers was solved in terms of new manufacturing methods; the design, performance and fire power of the P-39 are shown as well.

The Airacobra—16 mm., sound, color, 25 min. Many scenes of the Airacobra firing at a target on Lake Ontario. Tracer bullets and cannon shots are used throughout the picture to add interest and demonstrate the striking power of this interceptor pursuit ship.

The B G Corporation, 136 W. 52nd St., New York 19, N.Y.

Spark Plugs in Aviation—16 mm., sound, 30 min. Manufacture, inspection, and maintenance of spark plugs for aircraft engines.

Bureau of Mines Experiment Station, 4800 Forbes St., Pittsburgh, Pa.

How to Weld Aluminum—Three reels, sound, 16 mm. and 35 mm. An upgrading picture to instruct welders in the welding of aluminum.

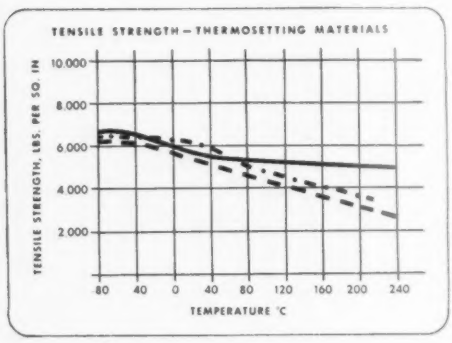
How to Rivet Aluminum—Two reels, sound, 16 mm. and 35 mm. An upgrading picture to instruct riveters in the riveting of aluminum.

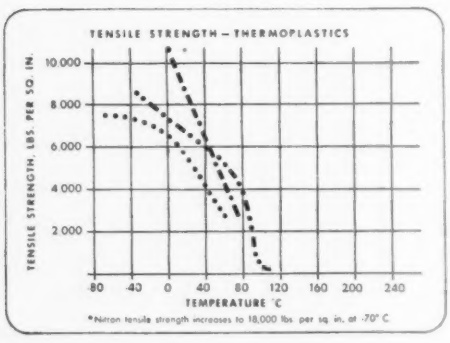
How to Machine Aluminum—Three reels, sound, 16 mm. and 35 mm. An upgrading picture to instruct machinists in the machining of aluminum.

Consolidated Aircraft Corporation, Publicity Dept., San Diego, Calif.

Building the PBY Record Breakers—16 mm., sound, 25- or 48-min. versions (specify which). Requests should be sent 6 to 8 weeks ahead of date desired. Audience of not less than 100 persons required. Evolution of a Consolidated patrol bomber from drawing board to acceptance flight.

WHAT EVERY ENGINEER SHOULD KNOW ABOUT TEMPERATURE VS. STRENGTH OF PLASTICS





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THIS advertisement very frankly reverses the usual sales approach. It skips lightly over the virtues of the products it offers for sale and dwells instead on the one "fault" most likely to queer a sale.

Chances are that you already have a clear, over-all picture of the many virtues of plastics as engineering materials . . . their usually high strength per unit of weight . . . excellent electrical and thermal properties . . . high resistance to atmospheric and chemical attack . . . ease of fabrication . . . virtually limitless range of integral color . . . etc., etc.

Very possibly, however, you do not have a clear picture of what happens to the physical properties of plastics over a wide range of temperatures. In the pre-war, gadget days of plastics very little data was available on which to base such a picture. As a result, you may still hesitate to investigate them for many applications which actually they would be fully competent to handle.

For example, these charts show that tensile strengths of Resinox phenolic molding compounds are only slightly affected by temperature, deviating from values at 77°F. by roughly plus or minus 15% over the temperature range of normal use, –60 to 160°F. On the other hand, these charts also confirm the rather obvious fact that temperatures likely to be encountered in service must be carefully considered before specifying a thermoplastic.

Of course, no one-page advertisement can hope to complete the picture, but much more data of specific interest to engineers is now available.

Since wartime demand for plastics in vital, heavy-duty jobs graduated these versatile materials practically en masse out of the gadget and into the engineering class, Monsanto's plastics laboratories have taken the lead in studying the effects of temperature on their physical qualities. Much of their work has been correlated and interpreted in the reports listed below which are yours for the asking. Simply mail the coupon.

The Broad and Versatile Family of Monsanto Plastics

(Trade names designate Monsanto's exclusive formulations of these basic plastic materials)

LUSTRON (polystyrene) • **SAFLEX** (vinyl acetal) • **NITRON** (cellulose nitrate) • **FIBESTOS** (cellulose acetate) • **OPALON** (cast phenolic resin) **RESINOX** (phenolic compounds)

Sheets • Rods • Tubes • Molding Compounds • Castings • Vuepak Rigid Transparent Packaging Materials

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SERVING INDUSTRY...WHICH SERVES MANKIND

Department A, Plastics Division
Monsanto Chemical Company, Springfield, Massachusetts

Please send me: ☐ Physical Properties of Polystyrene as Influenced by Temperature. ☐ Influence of Temperature on Mechanical Properties of Molded Phenolic Materials. ☐ Effects of Continuous Heat on Phenolics. ☐ The Family of Monsanto Plastics, a Guide for Product Designers.

*Name*_____

*Title*_____

*Address*_____

*City*_____

Curtiss-Wright Corporation, Airplane Division, Public Relation Director, Buffalo, N.Y.

Curtiss-Wright Answers the Call for Quantity—16 mm., sound, 20 min. Production of airplanes in Curtiss-Wright plants.

Curtiss-Wright Corporation, Propeller Division, Public Relations Director, Caldwell, N.J.

America First in the Air—16 mm., sound, 20 min. The story of Curtiss-Wright propeller manufacture. Commentary by Lowell Thomas.

Curtiss-Wright Corporation, Wright Aeronautical Division, Public Relations Manager, Paterson, N.J.

Wright Builds for Air Supremacy—Two- and five-reel versions, both 16 mm. and 35 mm. Narrated by Lowell Thomas. Manufacture of a Wright Cyclone 14-cylinder engine from its conception on the drawing board through foundry, production, and testing processes to final installation in an airplane.

Elmira Area Soaring Corporation, Federation Building, Elmira, N.Y.

Silent Wings—(RKO Pathe Sportscope) 16 mm., sound, 20 min. film on soaring flight.

Harris Hill—16 mm., technicolor, silent, 25 min. Picture of glider contests held at Harris Hill, Elmira, N.Y.

The Goodyear Tire & Rubber Company, Motion Picture Dept., Akron, O.

The Story of the Airship—Silent, 16 mm. or 35 mm. (state which), 15 min. Depicts developments from free balloons and blimps to construction and operation of airships like the "Macon."

The Air Fleet—Silent, 16 mm. or 35 mm. (state which), 15 min. Shows operations of small Goodyear blimps, pickups and landings on ships and buildings, towing gliders, etc.

Cushioned Landings—Silent, 16 mm. or 35 mm. (state which), 15 min. Shows landings, often under unusual and difficult conditions, made by airplane equipped with Goodyear "Airwheel."

Linde Air Products Company, General Publicity Department, 205 East 42nd St., New York, N.Y., or nearest branch office of the company.

Oxwelding and Cutting in Production, Part 1 (Film B-5)—16 mm., 15 min. Oxyacetylene process in production of automobile bodies, airplane fuselages and motors, and other products. *Part 2* (Film B-6), 16 mm., 15 min. Continuation of subject showing construction of pressure vessels, condenser heads, hand cutting of billets and steel blooms, and use of automatic shape cutting machines.

Lockheed Aircraft Corporation, Sales Promotion Dept., Burbank, Calif.

Look to Lockheed for Leadership—16 mm., sound, 35 min. A graphic story of a modern aircraft factory and its products. History of flying from the early pioneering days of the Wright Brothers to such modern exploits as Howard Hughes' Round-the-World flight. Fabrication of modern planes from the time metals enter the factory until they come out as a pursuit plane.

The Glenn L. Martin Company, Public Relations Director, Baltimore, Md.

Building a Bomber—16 mm. (Details available from the Company.)

National Advisory Committee for Aeronautics, 1500 New Hampshire Ave., Washington, D.C. Not more than one of the films listed below will be sent at a time. Three weeks' notice should be given when requesting loans.

Safe Flying—(nontechnical) 16 mm., sound, two 400-ft. reels. Film prepared for use at the San Francisco World's Fair. 40 min.

General Film No. 2—(nontechnical) 16 mm., silent, shows activities at the Committee's Laboratory at Langley Field, Va. The following technical films are all 16 mm., silent. A printed descriptive text giving introduction and running commentary to be read during the showing is available for all except No. 9 and the *Smoke Flow* film:

(1) *Some Effects of Fuel Injection Advance Angle on Combustion in a High-Speed Compression-Ignition Engine*—20 min.
(2) *The Fundamental Nature of Air Flows and Air-Flow Separation*—20 min.
(3) *Some Effects of Air-Fuel Ratio on Combustion in A High-Speed Compression-Ignition Engine*—20 min.
(4) *Some Effects of Air Flow on Combustion in a High-Speed Compression-Ignition Engine*—20 min.
(6) *Some Effects of Nozzle Design on Combustion in a High-Speed Compression-Ignition Engine*—20 min.
(9) *The N.A.C.A. Free-Spinning Wind Tunnel*—(no text), 20 min.
(12) *A Study of Air Flow in an Engine Cylinder*—20 min.
(13) *A Study of Combustion in a Spark-Ignition Engine*—20 min.
(14) *Slow-Motion Study of Normal Combustion, Preignition, and Knock in a Spark-Ignition Engine*—(one 800-ft. reel or two 400-ft. reels) 40 min.
Smoke Flow—Lift and Drag—(no text) four 400-ft. reels, 1 hour and 20 min.

National Tube Company, Frick Building, Pittsburgh, Pa.

Walls Without Welds—16 mm. or 35 mm., 4 reels, 50 min., illustrating manufacture of seamless steel pipe and tubes, from the mining of the ore to finished product, including laboratory tests and operations on seamless tubing as used in aircraft and other construction.

Rohm & Haas Company, Plastics Division, 222 W. Washington Sq., Philadelphia, Pa.

Fabrication and Repair of Plexiglas—16 mm., sound, 20 min. Methods of storing, handling, fabricating, repairing, and maintenance of this transparent plastic as used for gun turrets, observation domes, and other aircraft sections.

South Bend Lathe Works, 425 E. Madison St., South Bend, Ind.

How to Run a Lathe—Two 800-ft. reels, 16 mm., sound, full color. Representing most advanced technique for teaching lathe operation. *Reel 1.* The Metal Working Lathe—20 min., explains names, purpose, and operation of various lathe parts. Ideally suited for showing to beginners. *Reel 2.* Plain Turning—20 min., teaches many of the basic procedures encountered in all lathe work.

Trade Films, Inc., 8802 Melrose Ave., Hollywood, Calif. (Films available from this company upon payment of rental fees. State type of meeting at which films are to be shown when requesting rates.)

The Engineer's Relation to Production—35 mm., slide film (not movie), 30 to 40 min.; 140 slides on projection strip, no subtitles, commentary on phonograph record to be run with pictures, printed text also furnished. Produced in September, 1941. Visual exposition of design of aircraft parts in relation to problems of production—machinery, materials, and methods used.

The Engineer's Relation to Assembly—Same form and length as above.

United Aircraft Corporation, Sikorsky Aircraft Division, Stratford, Conn. Attention: C. L. Morris.

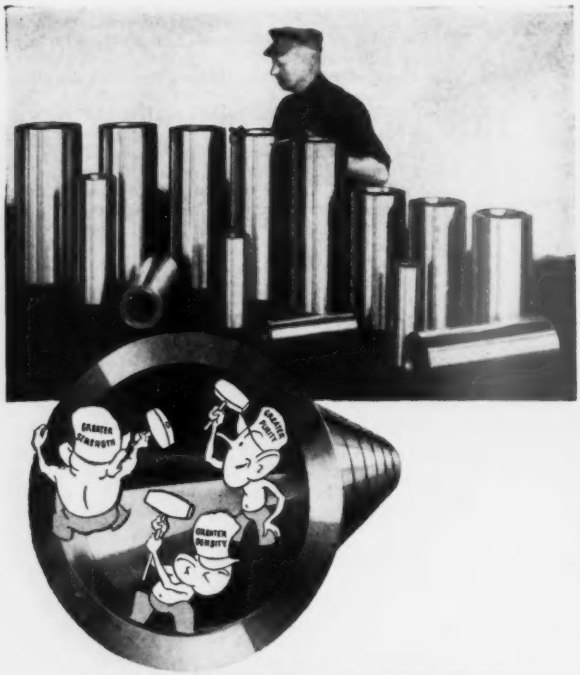
VS-300 Helicopter—Various short films, silent, 16 mm., some in color, may be obtained as available. Most of these have no titles but show views of Sikorsky's helicopter in flight and indicate the maneuvers that can be performed in this type of aircraft.

Vultee Aircraft, Inc., Public Relations Department, Vultee Field, Calif.

Messerschmitt 110—16 mm., silent, 25 min. Complete arrangement, structure, aerodynamic lines, equipment, and other pertinent facts about this German airplane. Also still photographs for display purposes relating to Vultee's mass production methods and various models.

Wilding Picture Productions, Inc., 1345 Argyle St., Chicago, Ill.

Unfinished Rainbows—(Produced for Aluminum Co. of America for free distribution.) Three and one-half reels, sound, full Technicolor, 16 mm. and 35 mm. (specify which). A "biography" of the aluminum industry, from the time of Napoleon III to the present. Development of modern mass production methods. Uses of aluminum.



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